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"Entrepreneurship, technology transfer and business model evolution in Academia"

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Thesis title:

Entrepreneurship, technology transfer and business model evolution in Academia:

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OVERVIEW OF THE THESIS

This research is carried out and presented in the form of three papers with the first and the second closely linked to each other likewise the third paper links the first two papers in the sense that they all focus on academic research. The first paper is a systematic literature review whereas the second and third are empirical papers. The empirical papers adopt a qualitative (second) and quantitative (third) methodology. The methods used are a multiple case study based on personal interviews for the qualitative paper, whereas a database analysis based on survey collected data for the quantitative one.

The first paper "Outbound Open Innovation in academia: A systematic review of the exploitation practices and outcomes in Universities" tries to understand the benefits in transferring technology or knowledge from universities. This research was carried out by evaluating the various modes through which technology or knowledge can be transferred from the university (and their Technology Transfer Offices, also TTOs) to industries. To carry out our review, we used Web of science as main source and look for journal articles only. Collected papers were later organised into four different streams of research:

- **A first stream focussing on knowledge transfer modes** including papers that discuss on the variety of ways through which academic inventions can be produced and marketed or transfer being it through the technology transfer offices, licensing, patenting. This category of papers occupied a greater percentage (29%) of the articles.

- **A second stream dealing with strategy, organisation and management related issues** where we put articles dealing with the process of organising and managing the various activities related to technology transfer and the strategies put in place by the owners of the intellectual property rights. Papers in this category occupied 21% of the entire research.

- **A third stream of research that we defined "Value network"** since dealing with the ecosystem of technology transfer (external subjects involved, their role and activities) and the benefits generated from technology transfer activity to such ecosystem and to the society as a whole . Papers in this section covers 24% of the entire research.

• **A fourth stream of research focussing on Performance** where we classified articles making mention of the positive outcome of this innovative research including the success recorded being it through technology transfer or collaboration (usually with Government for social benefits) making up 26% of the entire research articles.

The second paper tries to understand the role played by the TTOs in the transfer of this technology. In particular, this paper - that is a qualitative study – focuses on the role of TTOs dynamic capabilities and whether such capabilities have been implemented or not by the TTOs in order to develop their business models. To do that, we interviewed some technology transfer offices in Europe in 2019. The framework that we used in this research is borrowed from Teece (2006, 2007) where the author explained this concept by using three elements (seizing, sensing, and reconfiguring). The aim here was to understand if TTOs representatives that were interviewed implemented at least one of these items in developing their new business model or enhancing the already existing business model.

The third paper which is a survey analysis focusing on the relationship between frustration encountered by academics in carrying out their job and their attitude towards engaging in entrepreneurial activities. One of the motivations in writing this paper is that research have gradually shifted from the university to the society as many researchers and highly involved in entrepreneurial activities. Despite the level of stress involve in managing both activities, some researchers have still succeeded to become successful entrepreneurs while some have ended up in companies. This research was thus aimed at understanding how academic passion and frustration has either hinder or contributed to the creation of spinoffs by academic researchers.

In order to provide a better view on what this thesis is about, we summarised the research aims of the three papers in a tabular form by bringing out the title of the papers and a brief objective (Table 1).

Table 1. A summary of research papers and objectives

Paper title	Research objectives
Outbound Open Innovation in academia: A systematic review of the exploitation practices and outcomes in Universities	This paper aims at analysing the various forms of technology transfer and to come out the channel though which university benefit the most (financially)
The role played by dynamic capability in the development of business model in the Technology Transfer Office (TTOs): A qualitative research	This paper aims at understanding if the concept of dynamic capabilities (which include sensing, seizing, and reconfiguring) in implemented at the level of the university Technology Transfer Office in developing new models

Exploring the main drivers of academic frustration: a systematic scale development	The aim of this paper is to provide a sound, reliable and empirically validated measure of academic frustration.

INTRODUCTION TO THE THESIS

The study of entrepreneurship, technology transfer as well as business model evolution in Academia is fast growing as it has drawn the attention of many researchers in recent years which can be seen by many publications in this field. Thus, this field of studies has for over the years witnessed an increase especially in the 21st century that the world has become a global village thanks to the evolution of technology which have brought markets closer for easy transactions. In this light, both individuals and institutions have benefited from the concept as more and more people are gradually moving from being normal employees in companies and especially in academic institutions to creating their own businesses or be entrepreneurs (Krabel and Muella, 2009). This has been very possible since new technology generated from academic activities can easily reach the market thanks to academic entrepreneurship (Goethner et al., 2011).

Thus, most scientist have for over the years become entrepreneurs which has permitted them to produce and market their research or inventions as well as start their own companies to facilitate these transactions (Shane, 2004). Nevertheless, there is still a fast-growing research of academic researchers especially scientist wanting to become entrepreneur which has limited the literature in this domain to an extend (Rothaermel, Agung, & Jiang, 2007). Though most research in this field seems to be geared toward scientist becoming entrepreneur, most private sectors have also experienced the same phenomenon in the emergence of entrepreneurship as employees are becoming entrepreneur themselves (Fini and Lacetera 2010).

However, there is this conception that resources in carrying out entrepreneurial activities are always constraint since the founders need to start with some initial capital higher enough to cover certain expenses as an entrepreneur Powell & Baker (2014). Despite this, researchers have however taken up the challenges on embarking on this journey as it is said to be a growing phenomenon in our contemporary society. The fact that resources are constraint will help the young entrepreneurs to be prepared on the tasks ahead of them by making sure that their entrepreneurial activities become a success.

As explained by (Cassar, 2004; Harrison, Mason, & Girling, 2004), the idea of being an entrepreneur is not only backed by what the firms or organisations need to put in the market, but more especially on what the initiator or the entrepreneurs are able to put in order to realise their goal. Meanwhile, (Glaser & Strauss, 1967) have been concern with the challenges that are faced by these entrepreneurs as some of them do not really have an entrepreneurial background. Also, because as an entrepreneur (irrespective of the size and age) one is bound to face the same challenges that are faced by already existing entrepreneurs in their respective domains.

Consequently, most academic institutions especially those of the nanotechnology and biotechnology have gradually shifted from their traditional activities which was geared to carrying out research to a more industry oriented. This is because most of these scientific universities tend to be more collaborative with industries as they can better market their technology directly to these companies with ease (Toole and Czarnitzki, 2007). Therefore, according to these authors, there exist in recent economies the idea of entrepreneurship which is mostly science-based since novel research are easily converted to new products (thanks to the business models put in place) that are highly marketed. This explains why some authors

think that scientific research is becoming more proactive in their activities especially towards the commercialisation of their technologies which is usually carried out through main channels such as patenting, licensing firm founding as well as through consultations (Krabel & Mueller, P. 2009).

The concept of Business Model in the university is said to be in transition as it has continuously changed in the past decades resulting from the development of knowledge-based economy with the main element of innovation and growth being the universities (Etzkowitz and Leydesdorff, 2000). Therefore, the processes of innovation and technology transfer are fast growing into what is term open innovation which is mainly based on the commercialisation of university knowledge (Chesbrough, 2010). Also described as a novel unit of analysis, the university business model has become very important especially at the level of the technology market where the competition is high (Zott et al. 2011). Thus, there is a great need in carrying out additional research in the evolution of the business model and how it can positively impact the performance at the level of the universities as well as organisations (Zott et al., 2011; Schneider and Spieth, 2013). For instance, some authors have used the stakeholder viewpoint in studying the shifting nature of the business model in the university with the hope of developing and refining novel theories in these areas (Miller et al., 2014).

According to McMillan et al., (2000), university researchers especially scientists have greatly been involved in both the creation as well as participating in the running of most spin-offs thanks to the development of new business ideas. This participation has greatly enhanced the growth of economies worldwide especially at the level of the industries dealing with Biotechnology Audretsch and Stephan (1996). The positive results obtained from this phenomenon have for over the years encourage most universities to effectively develop new models in order to better implement the concept of entrepreneurship in their institutions which today is one of the most research areas (Shane, 2004; Di Gregorio and Shane, 2003).

Thus, providing universities with an equity investment from the spin-off companies that they have created. Despite the fast-growing research in this field, most attention has been in the past focused on either specialised field of technology as well as institutional factors. On the other hand, only little have been mentioned on the motivations that individuals must start their own business and become academic entrepreneurs (Rothaermeletal.,2007).

This research is thus focus not only on the organisational level, but more at the level of individual's perception on their intention, attitude, and behaviour towards the creation of spinoffs. We also realise during this study that, most of these technologies or knowledge when produce at the level of the university sometimes face some difficulties to reach the technology market. However, those that manage to reach are always face with either the issue of competition of copyright violations (IP protection issues), as such might not be effectively yield the intended economic value (Somaya et al. 2011).

Therefore many universities have now combined their resources in the creation of some departments known as the technology transfer offices (TTOs) which are either directly under the university or operates as an individual entity. These TTOs as explained by Reitzig and Puranam (2009) mostly concentrate on the legal part which involves the protection of the IP since studies have shown that most universities do not have very strong mechanisms as well as similar properties in the protection of their IPs. Thus, the process through which knowledge is being transferred from the university to industry is a simple linear flow which according to

(Harmon et al. 1997) include two actions with the first being the laying down of the groundworks (in other words presenting and assessing patents) and authorisation (that is, negotiating the term of the contract between the owner of the license and the university) of the technology

Furthermore, the idea of technology transfer from university to industries have been highlighted by many scholars, with only little actually mentioned in the process of transferring technology to companies directly from the faculties. This idea has been shared by Dechenaux et al. (2009) and Audretsch et al. (2012) that for there to be an effective transfer of technology or knowledge, there needs to be some level of collaboration between the faculty involved in the production of this knowledge and the firms that finally benefit from them. With this idea in mind, universities have through their TTO bring in not only the faculties but also the researchers who come up with such ideas.

As such these TTOs have managed the disclosures or researchers' patents and have licensed them which have generated enough revenue not only to the researchers but also to the university (Aghion and Tirole 1994; Friedman and Silberman, 2003; Panagopoulos and Carayannis, 2013; González-Pernía et al. 2013). For instance, $40 billion was generated in the US universities specifically in 2005 in economic activity which intends created about 628 start-ups as well as 932 licenses.In addition, reports coming from the AUTM Licensing Activity Survey (2012) also revealed that about 705 start-up companies were created with the universities in US accounting for about 5130 licenses obtained the invention of technology.

On the other hand, not all researchers do disclose their inventions to the TTO as most of them For instance, in the United States, 26% of the patents produced by researchers were allocated directly to companies instead of passing through universities as was usually the case (Thursby et al., 2009; Färnstrand, Damsgaard and Thursby 2013). With respect to the above example, it can be realised that the concept of technology transfer has evolve over time and it is still increasing due to the recent development of new technologies especially at the level of the universities. This is because, before the early 80s, most universities around the world were managed solely by the state which gave room to very little technology invention and evolution. The situation however changed during and after the 80s with the introduction of some basic laws by the governments which liberated most of the universities to own and manage their inventions Grimaldi et al., (2011).

For instance, with the introduction of the Bayh-Dohl Act in America in the 80s, many universities had the liberty not only to control but also to commercialise what they generated from their institutions which were mainly new technology or knowledge (Kenney and Patton 2009; Siegel and Wright, 2015). At the same time, there were also similar legislation passed in Europe (to own and protect IPs) and some Asian countries (for instance Japan, Korea, and Taiwan) liberating the sector and giving the opportunity to university to produce and market their inventions (Chang et al., 2008; Casper, 2013). In addition, there were also some laws enacted in Canada, Israel as well as in Australia permitting universities to market their inventions without any direct influence from the state (Grimaldi et al., 2011). Capitalising on this fact, many universities became interested in technology transfer which allowed them to come out with new methods on how to harmonise and market this knowledge.

Before then, scientists were not motivated in developing new inventions since most of their works remained in the shelves because of a limited market to these inventions.

Nevertheless, with the liberation of the sector, many more researchers are being encouraged by the university not only invent new technology but to disclose them to the TTO or related office for better commercialisation and protection of the IPs (Penin, 2010). Thus, the idea of technology transfer began yielding fruits when in some universities in Europe, researchers were given some rights over their invention. For instance, in Italy (precisely in the university of Trieste), there was what is call professor privilege which permitted researchers to have control of over 70% of their work (Lissoni et al., 2013). Though this idea was considered a win-win to both the university and the researchers, some researchers, however, took advantage of the situation and marketed their inventions directly to the technology market to companies without necessarily disclosing them to the TTO.

As time goes by, most researchers realised that they could both be inventors and researchers at the same time. That is, to be involved in carrying out their normal duties as researchers as well as getting involved in the creation of spinoffs. Meanwhile, some researchers have partially or completely abandoned their research activities to being full time entrepreneurs as it requires a lot of time and investment. This according to Jain et al., (2009) is termed academic entrepreneurship were researchers tend to have more financial benefit by carrying out entrepreneurial activities which have greatly limited their research activities. Nevertheless, the reasons why researchers have decided to move from their traditional ways of doing research to involving in entrepreneurial activities are still not very clear as not many studies have been carried out in this field.

This transition is very important in recent years because it helps us to understand how the business model has evolved and if this evolution have altered the perception and the behaviour of academics and universities towards academic entrepreneurship. As such, there is a need to further understand the entrepreneurial behaviour of academics and universities as it is increasingly being studied. For instance, Ranga, et al., (2003) witnessed a significant increase of articles in the study of both research groups (which are closely related to the university) that have greatly stimulated the behaviour of academic entrepreneurship.

On the other hand, the innovation of the business model is mostly designed in a systematic manner which will intend to generate value to almost all the stakeholders who are involved in the running of the institution. According to Lenssen, et al., (2013), not enough tools have been developed in the existing business models which could assist most firms to sustain its business model since the concept has been regarded mostly in a more general form. Likewise, other authors have come out with some very popular frameworks which supports the general business models that are put in place known as the business model canvas.

As highlighted by Osterwalder and Pigneur, (2010), this form of a business model (though from a very strong academic viewpoint) is said to be very narrow as its focus is on the customers. Thus, a greater part of the stakeholders (for instance, the local communities, suppliers, as well as the society at large which in this case may involve the state and some Non-Governmental Organisations) are cut off from the benefits of these models either directly or indirectly. As such, Amit and Zott (2014) explain that the process through which a business model designed is referred to what they termed dynamic capability.

As recently explained by Burisch and Wohlgemuth (2017), the concept of Dynamic capabilities is said to be one of the most studied concepts which is at the same time said to be very contentious in recent technology innovation research. Therefore, there still seems to be

some scarcity in the literature on academic business modelling such that the role played by dynamic capabilities in BMI is unclear in such context (for the second paper) or that it is important to understand the individual and psychological dynamics that drive researchers to decide to become entrepreneurs since they are anything but clear (third paper).

Overall, Universities have increasingly involved in the sale and/or licensing of Intellectual Property Rights, mainly in the form of patent selling, technology licensing, and contract research. Despite the "why" that happens, it is almost clear, there are correlated research questions that deserve further attention. Also, the "how" this happens (through which forms) and under "which conditions" Universities are performant in carrying out such research activities are attributed to the definition of "Outbound Open Innovation".

Thus, universities have for over the years develop new and better ideas such as creating technology transfer offices to market their technologies (Lichtenthaler, 2009). This has to an extent harmonised the sector as well as create some tasks here and there. For instance, there has been an increase in some challenges that these offices face with a major reason being limited funds to carry on with the technology transfer activities. Therefore, these TTOs are compelled to advance new means by developing and implementing new business models that can generate them more income. However, our claim here is to know the extent that dynamic capabilities (sensing and seizing opportunities as well as reconfiguring the business models) can influence the successful implementation of a business model.

Consequently, researchers have gradually moved from the traditional ways which involve teaching and carrying out research to a more advanced way involving the creation and filing of patents as well as the creation of spin-offs. This shift has to an extent complicated the system due to the challenges faced by most scholars in managing both activities. This research in the third part also seeks to deepen the link between the frustration academics may perceive in carrying out their job and their entrepreneurial attitudes, intentions, and behaviours. The research is carried out at an individual level crossing psychological and managerial literature permitting us to understand the role of academic passion and frustration and the antecedents of spinoff intentions.

The survey is structured in two phases where the first is to test for the reliability of the elements or factors that are used in measuring the validity of the constructs. The results of this section clearly indicate the validity of the measurements after a series of analytical testing (factor analysis with Cronbach's Alpha) was carried out. In the second part (after testing and approving the measurements), a snowball technique shall be applied to increase the sample. The results shall permit us to obtain more accurate and complete results which shall help us in fully addressing our research question.

Generally, the first paper aims at focusing just on a specific part of an enormous literature dealing with technology transfer from Academia, and to carry out a systematic review of the literature on the economic exploitation of the knowledge produced (in any form) and sold by universities. The results show that licensing is the channel most used by researchers or by universities to market their knowledge which also accrues much income to these institutions. The second paper aimed at bringing out the role play by dynamic capabilities in the evolution of the business model in universities' technology transfer offices.

In this section, we focused on the role played by dynamic capabilities in building up new business models in the TTOs where we explained and demonstrated detailly the concepts of sensing, seizing, and reconfiguring proposed by Teece (2006, 2007). The results indicated that a greater part of the TTO representatives that were interviewed were involved in seizing opportunities to build up their business models. Whereas only a few of them sensed these opportunities from the start since most of the TTOs were young with limited staff from diverse backgrounds. Meanwhile, reconfiguring new business model was least thought of since they focus only on technology transfer.

First paper:

Outbound Open Innovation in academia: A systematic review of the exploitation practices and outcomes in Universities.

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Abstract

In recent years, Universities have been increasingly involved in the marketing and in the licensing of their Intellectual Property Rights, mainly in the form of patent selling, technology licensing, and contract research.

Despite the "why" that happens is almost clear, there are correlated research questions that deserve further attention. And mainly the "how" this happens (through which form) and under "which conditions" Universities are performant in carrying out such activities that we attribute to the definition of "Outbound Open Innovation".

The aim of this paper is to focus just on a specific part of an enormous literature dealing with technology transfer from Academia and to carry out a systematic review of the literature on the economic exploitation of the knowledge produced (in any form) and sold by universities. The results indicate that a greater part of the articles in this research analyses the commercialisation modes with licensing being the main channel of technology transfer, whereas analysing the performances of the various research modes occupied the second position. In addition, some papers also mention the value network of which fewer articles discussed the strategies as well as the managerial perspectives.

We do that by analysing the literature retraced in 42 academic journals and 118 papers specifically dealing with this research topic. Differently from previous works carried out on this topic, this review is the first to systematically analyse literature on the financial benefit acquired by universities from technology transfer and to analyse the best means through which the income could be generated being it licensing, commercialising, the creation of spin-offs and transferring knowledge or technology to other institutions or establishments.

Keywords: Licensing, commercialisation, intellectual property right, patent, university, and spin-off.

1. Introduction

The pace of innovation processes is accelerating intensely in many sectors as new technologies – and especially enabling technologies like Cloud Computing, Artificial Intelligence (AI) and Internet of Things (IoT) – become more universal and embedded in a larger variety of products (Porter & Heppelman 2014; Macho-Stadler et al., 2007). In such a context, innovating alone is less and less an option for firms because of the risks connected to rapid technological obsolescence and the continuous discontinuities in technological development (Bianchi et al., 2011). Thus, a new approach to innovation, more open to collaboration with third parties, is needed by organisations aspiring to remain on the innovation edge (Chesbrough, 2007).

Such a scenario opens innumerable opportunities for Universities because of their role as producers of base knowledge and new technologies (Phan and Siegel, 2006). However, big challenges come as well with these opportunities such as exposing the universities to the competition which might result in conflicting ideas in the various faculties (Baglieri et al., 2018). More especially if we consider the inability of many universities and university researchers to transfer to the market the knowledge and the technology they produce (Mowery et al., 2002). The focus of this paper is on the business side of University Technology Transfer (UTT) which we call University Outbound Open Innovation (UOOI).

Though the concept of "open innovation" was first mentioned by Von Hippel in the 90s and was emphasised in 2003 in his studies about open source software, it was later on highlighted by Henry Chesbrough (2003) where the author defined it as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough 2006, 1). As explained by this author, open innovation has two sides: inbound and outbound. While inbound open innovation refers to the purposive involvement of third parties in the provision of new ideas and/or in the development of a new product or process, outbound open innovation refers to the process of market valorisation with third parties of knowledge, ideas and other assets owned by an organisation. The general aim of open innovation is to maximise the overall "return on innovation" of the organisation or firm, which corresponds to the sum of efforts (financial and non-financial) put in innovation activities (Chesbrough 2003, 2006; Kutvonen, 2011).

Some authors Lopes et al. (2018) have also discovered in recent years that open innovation is a field of research that is increasingly being developed as can be observed in the increase in the number of publications in the field. This is a phenomenon that has just begun and as such needs more attention for a better analysis. According to Bogers et al., (2017), it brings individual frameworks and a variety of levels of analysis to the research design, demanding more theory development efforts. Furthermore, the term open innovation is a fundamentally dynamic process, which gives the need to be combined with some dynamic elements so that not only a better analysis be done, but a good outcome should be achieved (Appleyard and Chesbrough, 2017). With UOOI we refer at the strategies, the processes, and the organisational routines aimed at valorising in the market, alone or in combination to other organisations, the knowledge, the resources, and the capabilities of Universities and academics. Conventionally, the mechanisms through which universities have valorised their technologies is through selling or licensing Intellectual Property Rights (IPR) to already established companies (Penin, 2010).

Recent literature has discussed how Universities have been changing, especially in the very last decades, in relation to the valorisation of their knowledge assets (Özel & Pénin, 2016; Ho

et al., 2013). Above all, such literature has highlighted that many changes have occurred both internally – more precise transfer strategies (Siegel et al., 2003); new modes of knowledge transfer (Mowery et al., 2001); creation of ad-hoc structures, as technology transfer offices (Thursby & Jensen, 2001; Chang et al., 2015; Baglieriet al., 2018). – Also, externally, for example, through the foundation of joint research laboratories with firms (Chatterjee & Sankaran, 2015) or the creation of university-industry incubators (Rothaermel et al., 2007). Empirical evidence of best practices is not missing either in the literature as the respective capabilities for technology transfer realisation have a significant positive effect on technology transfer performance, whereas there is no significance in the capabilities of identifying technology transfer opportunities (Bauer et al., 2018).

What we miss, in our opinion, is more conceptual knowledge on the theme. And we urge a comprehensive and updated framework aimed at systematising existing literature that can help researchers in better positioning their research on such themes. The rest of this paper will be organised as follows: first, we provide a brief background on the evolution of technology exploitation in general, later a detail systematic analysis of the methodology used in this research, then a review of the literature by categorising into research streams, also the main findings emerging from the research and lastly the discussions and conclusion of this review.

2.0 Background

2.1 Technology transfer in University and beyond

Technology transfer is the process of "transferring a technology-based innovation from the developer of the technology to an organisation utilising and applying the technology for marketable products" Kirchberger & Pohl, (2016: 5). Nevertheless, the process originates by an invention which is later disclosed to the market through specific means and intermediaries, bringing a certain impact on the society (Chang et al., 2015). It is presumed by some scholars that, defining technology makes it less challenging in defining technology transfer. Bozeman, (2000: 629) thus refers to the term technology transfer as ''the movement of know-how, technical knowledge, or technology from one organisational setting to another''.

Nevertheless, there are many uses of the term ''technology transfer'' mainly in describing and analysing a wide range of organisational and institutional interactions that involve some form of technology-related exchange. This includes sources such as private firms, government agencies, government laboratories, universities, non-profit research organisations, and even entire nations. Thus, technology transfer has been greatly used to describe the processes through which ideas, proofs-of concept, and prototypes move from research-related to production-related phases of product development.

Furthermore, based on the annual conference of the Technology Transfer Society in 2011, Technology Transfer in an International Economy was devoted to bringing together professionals from academia, research institutes among business practitioners (Audretsch et al., 2014). These authors further confirm that the main objective is to promote the movement of federally developed ideas, knowledge and technologies created in public institutions to the marketplace for commercialisation mindful of its numerous objectives, which depends on the resource, user or mechanism. Abdul Razak, A., & Murray, P. A. (2017) in the same light express the need for university research to be strengthened by relating to industries to take full advantage of the commercial opportunities.

In addition, these definitions also differ substantially depending on the discipline as well as the purpose of the research (Audretsch al., 2014). For instance, economists such as Dosi, (1988) tend to define technology based on the properties of generic knowledge, focusing especially on variables that relate to production and design. Also, sociologists tend to link technology transfer to innovation and to view technology, including social technology, as ‘‘a design for instrumental action that reduces the uncertainty of cause-effect relationships involved in achieving the desired outcome’’ (Zhao and Reisman, 1992, 14). From the arguments put up by these authors, one can further conclude that those from the business disciplines concentrate mostly on the stages of technology transfer, particularly relating design, production stages, and sales, to transfer. Whereas on the other hand, management researchers are more likely to focus on the intersectoral transfer and on the relation of technology transfer to strategy.

It was discovered that at the real beginning, market exploitation opportunities for new discoveries are nothing but clear. This could be observed from the uncertainty of the activities of base research, which is equally carried in universities, research centres and private firms. However, inventions often fail to reach the market not for technology-related reasons, but for management-related ones (Ismail et al., 2011). On the other hand, some authors have argued that open innovation brings about the development of nations through innovation and constructive collaboration, through knowledge transfer. Developments in this area are still emerging, and some opportunities are resented (for instance the open science, co-creation of knowledge and open innovation triangle), as great opportunities to generate an original contribution from research to open educational theory and practices (Ramírez-Montoya & García-Peñalvo, 2018).

3. Methodology

We carry out a systematic review of the literature that focuses on the process of market exploitation of knowledge assets possessed by Universities. Therefore, our interest - as earlier mention in the introduction - is just and only limited to the process of market valorisation (in any way possible) of the discoveries made by University researchers. In this case, a multi-step process was carried out where we began by combining some key terms which are related to the research topic with the aid of Web of Science as the main search engine as well as google scholars. The following keywords; “Technology Transfer”, “Patent”, “Licensing”, “Exploitation”, “Open Innovation”, “Outbound Open Innovation”, “Intellectual Property Right” were combined with other keywords such as: “Universities”, “Spin-Offs”, “Academia” as well as “Science” which in all initially produced thousands of results.

Following this systematic review, some of the combined words generated a huge number of entries which were difficult to import into endnote before the elimination was done. For instance, “Technology Transfer” AND “University” generated 4,551 results, also “Licensing” AND “University” generated 4,651 entries. On the other hand, some of the combined words did not have many entries for instance “Outbound Open Innovation” AND ‘University’ generated only 3 entries. On this note, each combination was treated separately. To narrow down this search, it was refined by selecting only Journal Articles and Review as well as restricting the category of search to only Management Journals. At this point, only articles that contained at least one of the keywords were considered, where we ended up with 1754 papers. From this stage, each entry was exported into endnote by carefully considering

only articles that centred on university invention, university technology transfer, commercialisation and above all patenting and licencing in university. Here, the number of articles were further reduced to 340 that was then prepared for categorisation.

In the next step, the papers were then organised in a word excel in order of: The Authors, Title, year, Journal Type, Volume, Issue as well as Abstract. In the column after the abstract, a simple categorisation method was designed by grading the papers using a Likert scale from 1 to 5 with respect to how close the paper is to the main keywords. The number 1 represents the least of the keywords and 5 being the papers with most of the keywords. This categorisation permitted my supervisor to also categorise these papers where we later agreed and disagreed with some of the papers and had to come to a consensus on the elimination criteria which shall be discussed in the next paragraph.

Furthermore, this categorisation and elimination of papers were carried out by carefully reading not only the titles of the articles and their abstracts, but as well downloading (mostly through Google scholar) and reading (not in detail) the full version of the papers. The first categories of papers that were eliminated are those articles that made mention only about Patent diffusion and patent citation. These categories of papers (78 articles) discussed mostly the cost that universities incur in carrying out research and not the benefits which is the focus of this research.

Following the second elimination criteria, 70 articles were identified which mostly focused on university - industry collaboration for other purposes other than carrying out an income generating activity. In some of these papers, industries, enterprises, as well as firms, were instead the beneficiaries as most of these corporations uses universities to achieve their respective goals. In addition, the next category of papers that were eliminated from the main review papers (74 articles) explained instead the theories that are involved in carrying out research in this area and not mentioning any benefits being them financial to be obtain by the universities.

With respect to the previously mentioned criteria of search, only 100 articles satisfied the search results which were considered by the author to lay the foundation for this systematic review. In addition to these papers, some 18 paper were carefully selected from web of science and google scholar including some recent publications to update the research. As earlier explained above, the time limit of this research was not initially included in the search criteria reason being that this field of studies is not too old, since we consider 2003 as a year of breakthrough in this research area. However, the majority of article found was in 2016 and as such the articles that are used in this research were published in the period from 1998 onward as shall be seen in figure one (fig. 1). It was observed that a greater part of the articles used in this systematic review were published in 2016 which confirms the newness of this field.

After the 118 papers were obtained, the categorisation was further deepened by adding more columns after the scale evaluation. These new columns are: Paper type, which include conceptual papers; empirical papers as well as review papers. the second is Research Method which involves in this case three methods namely: Quantitative; Qualitative and lastly the Mixed method. Furthermore, we also have sources through which data was collected in these papers such as: Case study; Survey; Investigation; Interview; Experiment; Content Analysis; Ethnography; Data Mining; Statistical Analysis; as well as Annual Report. In the next column, we categorised according to the methods of analysis, where we came up with Method of analysis such as: Disruptive Capacity; Regression; Comparative Cross case Analysis;

multidimensional process; Multiple methods; Descriptive Analysis; Data Envelopment Analysis (DEA); cohort analysis; Descriptive Statistics; Technology Transfer Model; Multiple Case Study; content Analysis; Input-Output Model; Game-theoretic model; practice-base analysis; Market analysis; Multivariance Analysis; Multi-Stage Process; Revenue Maximization Model; Intermediate Input Model; Two-Stage Model; Multivariate Probit Model; Company Start-up Model; game-theoretic model; Conceptual Model; cognitive model; Licensing and Spin-off; Social Network Analysis, Systematic Literature Review; Semi-Structured Interview; Panel Analyses and Cross-Section Estimates; Meta Data Analysis

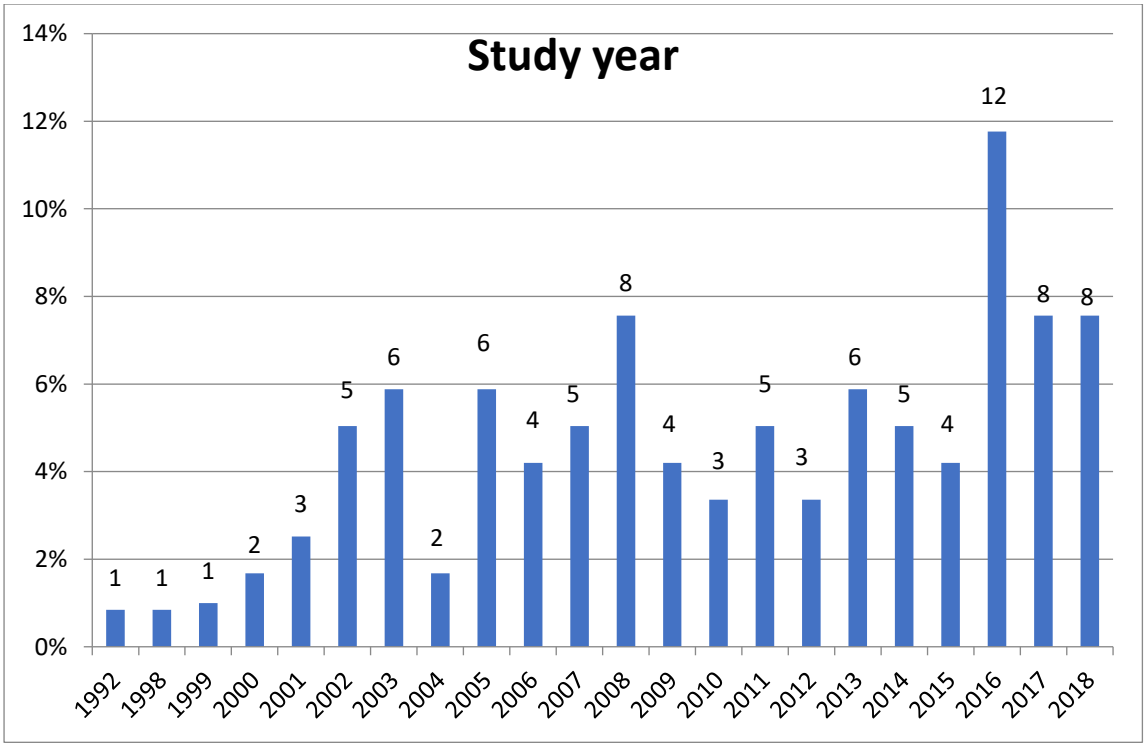

Fig. 1 Articles published from 1992 to 2018.

figure 1 shows that, there has been a slide increase in the publications from 1992 up to 2003 where many scholars started developing interests in this field of studies. Thereafter was a fluctuation in the publications from 2004 to 2015 with 2008 having the highest percentage (8) in terms of publications. Also, the least publication in this field according to the data collected in this research was in 1992, 1998, and 1999 equivalent to 1% each. Reason for this fluctuation could be that researchers became interested in this field of studies after the publications made by Chesbrough in 2003 and 2006.

From 2011, there was a continues but slide increase of publications in this field of studies where it escalated in 2016 with a greater percentage of 14%. Studies show that the number of researches carried out in this field shall be greater in the future compared to the previous years as this field of research remain one of the areas that have not been fully exploited by many scholars. The years 2017 and 2018 shows that there is still much research to be carried out in this field as it has now been extended into companies and the society at large. Note should be taken here that the term OOI is not a new phenomenon, as it has existed many years back but with different appellations. This paper was recently updated by adding six other papers which

are more focus on the relationship and benefits that universities obtain through their collaboration with some of the industries.

4. Literature review

4.0 Introduction

In this section, we shall review some literature on the diverse arguments brought forth by many scholars from their various field of studies with respect to open innovation and how some of these authors have approached the term technology transfer. Our argument here shall centre on the evolution of the literature on the transfer of knowledge in the universities as well as the application of the open innovation perspective in university technology transfer. The literature shall later be evaluated by coming out with some finding concerning the details of the articles that were involved in carrying out this research. This classification shall help us to identify and come out with some streams of literature which shall then be further classified with respects to the authors main idea.

To begin with, Friedman & Silberman, (2003) highlight that technology transfer has been cited by many university administrators as an indication of economic growth as well as the main source through which universities derives its revenue, considering the reduction in university funding. According to these authors, the fact that the Patent and Trademark Law Amendments Act, P.L. 96-517 was established especially in the US and elsewhere in Europe and Asia, rendered this concept uniformed. This uniformity as explained by Friedman got rid of the restrictions on university licensing, allowing a rise in university patents own resulting from federal research grants. Thus, the aim of this law was to permit universities to licence their research to industry for commercial development in the public interest.

As explained by Roessner et al., (2013), there has been several efforts in the improvement of technology transfer alongside those of the National Science Foundation as well as the organisation for Economic Co-operation and Development. Thus, the effort by faculty and the firm's investment will determine the success of the technology transfer (Siegel et al., 2003). For example, there has been a long history of technology transfer in the US university system dating far back before the 80s, and these activities have been rooted in the motivations created by the unusual scale and structure of the US higher education system as compared to many Western European nations or Japan (Mowery and Sampat, 2005). This situation has however witnessed a significant change in the early 2000s, starting from the UK, France and Spain and later spread in most European countries, where universities, rather than professors or scientists, retained the ownership over academic patents (Geuna & Rossi, 2011; Crespi, et al., 2011).

It is in Academia that TT – in the form of University Technology Transfer, or simply UTT from now on – has been studied the most, for the primary role played by Universities as providers of base knowledge in many scientific and technological fields (Friedman & Silberman, 2003). However, concerns have been raised that this increased activity suggests that university scientists and engineers might be moving more towards applied research and away from fundamental (basic) research in efforts to capture some of the gains from licensing (Thursby and Thursby, 2007).

UTT has been abundantly studied both in economic and managerial literatures and from different angles (Friedman & Silberman, 2003). And the definitions given by scholars reflect such differences in the perspectives used. For example, the following authors share a similar definition. While Vinig & Lips, (2015) define UTT as "The results of research from universities to the commercial sector", Han & Kim, (2016) also consider this aspect as "The transfer of the research output from universities to the commercial sector". The similarity in these definitions is that, these authors mention the fact that the innovation or knowledge generated is always carried into the technology market since results and output can be used interchangeably.

Friedman & Silberman, (2003) further provided a different definition where they define UTT as a "The process whereby invention or intellectual property from academic research is licensed or conveyed through use rights to a for-profit entity and in the end commercialised". A similar viewpoint is shared by Mesny et al., (2016) and Kirchberger & Pohl, (2016) who refer to UTT mainly as a "process". And precisely one through which technology is being transferred or moved from the inventor to the society which is later used to produce goods or services destined for the market. On the same vein, Thursby and Thursby (2002) describes Technology transfer as a three-stage production process involving multiple inputs such as invention disclosures, intermediate inputs and license and option agreements.

Author	**Journal**	**Definition of TT**
Chen, A., Patton, D., & Kenney, M. (2016: 892)	Journal of Technology Transfer, Vol. 41, N. 5.	It "…equate(s) to patents, technology licenses, and university spin-offs".
Friedman, J., & Silberman, J. (2003: 18)	Journal of Technology Transfer, Vol. 28, N. 1.	"The process whereby invention or intellectual property from academic research is licensed or conveyed through use rights to a for-profit entity and in the end commercialised"
Vinig, T., & Lips, D. (2015: 1036)	Journal of Technology Transfer, Vol. 40, N. 6.	"The results of research from universities to the commercial sector".
Siegel D. S., Waldman D. A., Atwater L. E., Link A. N. (2003: 3)	Journal of High Technology Management Research, Vol. 14, N. 1.	"The spreading of information through transfers of employees from one division or country to another referred to as intra-firm transfers of technology. University Industry Technology Transfer (UITT)".
Mesny, A., Pinget, N., & Mailhot, C. (2016: 2).	Canadian Journal of Administrative Sciences, Vol. 33, N. 4.	"The transformation of research results into technology whose intellectual property can be protected and transfer from university to existing company or a spin-off created purposely for commercialising this technology through granting IP rights in return for financial consideration".
Han J. and Kim J. (2016: 3)	International Journal of	"The transfer of the research output from universities to the commercial sector"

	Innovation Management, Vol. 20, N. 8.	
Thursby, J. G., & Thursby, M. C. (2002: 1).	Management science, Vol. 48, N. 1.	"Technology transfer is a three-stage production process involving multiple inputs such as invention disclosures, patenting or intermediate inputs and licensing and option agreements".
Arvanitis, S., Kubli, U., & Woerter, M. (2008: 1866)	Research Policy Vol. 37, N. 10.	"Technology transfer is defined as any activity that aims at transferring knowledge or technology that may help whichever academic institution or company to further carry on with its activities."
Rasmussen, E., & Rice, M. P. (2012: 3)	International Journal of Technology Transfer and Commercialisation, Vol. 11 Ns. 1-2.	"Technology transfer is the process through which the outputs of academic research are conveyed to those who make use of the research results".
Kirchberger, M. A., & Pohl, L. (2016: 5)	The Journal of Technology Transfer, Vol. 41 N. 5.	"Technology commercialization / Transfer is defined as the process of transferring a technology-based innovation from the developer of the technology to an organization utilizing and applying the technology for marketable products"

Table 1. Summary of various definitions of University technology transfer.

Contrary to the definition provided by previous authors, Siegel et al., (2003) refer to University Industry Technology Transfer (UITT) as the movement or better still the transfer of workers of a company either from one division to another or from one country to another either within the same company or in other companies. This definition however does not actually precise the concept of technology as stipulated by other authors. For instance, Chen et al., (2016) refer to the case of China and some Western nations where these authors explain that these countries have no standard definition yet, of what university technology transfer is, rather they compare it to patents technology licenses, and university spin-offs.

4.1 The evolution of the literature on UTT.

Along the centuries, the main responsibilities of academics have been to produce new discoveries for the benefit of the whole humanity and to instruct and tutor pupils to become future scholars (Litan et al., 2007). It is just in the very last decades of a millenarian history that we have been assisting to an upsurge of the proclivity towards the market exploitation of the knowledge produced in universities (Breznitz et al., 2008 and Schmitz et al., 2017). This idea has in recent years provided modern universities with the opportunity of being multi-objective where they can perform a wide range of activities in tandem, geared towards the

development of economic and social aspects irrespective of their historical differences. (Etzkowitz 2001, 2013).

Following the evolution of the transfer of university technology, Youtie and Shapira (2008) are of the view that knowledge factory has been the role adopted by universities which is manifested through the transformation of research inputs (mainly young researchers and funding) into output which comprise of highly skilled young graduates with outstanding performances and publications. As concerning the works of Geuna and Muscio, (2009), there has been a gradual shift from basic science to a more applied research which has grown significantly after WW2, mostly in some disciplines such as computer science and aeronautical engineering, biotechnology and nanotechnology, chemical, electrical, in addition to agriculture and health services.

The process of knowledge transfer has for the last two decades been institutionalise which has led to the growth of new internal and external organisational arrangements in the university (Geuna and Muscio 2009). These new arrangements (science parks, Technology Transfer Offices, Business incubators and accelerator) helps to link university and industry who have for the last three decades been operating as separate entities. Thus, the patenting of inventions is increasingly considered an effective strategy to improve the speed and the efficacy of knowledge transfer process from academia to industry, and in turn to promote the universities' ability to contribute to social and economic innovation and development (Geuna & Rossi, 2011).

In some Countries such trend has been favoured by specific legislation acts such as the Bayh-Dole Act in the US or the Science and Technology Basic Law (STBL) in force in several Asian countries, including Taiwan, Japan and Korea (Chang et al., 2008). Similar legislation initiatives aimed at ruling the ownership and the management of Intellectual Property Rights (IPR) and the commercialisation of patents in Academia were also adopted in the European context (Penin, 2010 and Casper, 2013). Although the Act was followed by a wave of entry by universities into growth in the management of patenting and licensing, several universities already established technology transfer offices and/or hiring technology transfer officers far before its enactment (Phan et al., 2005; O'Shea et al., 2008).

Weckowska et al., (2018), explains that legislative frameworks may stimulate the development of local practices for the management and exploitation of intellectual property (IP), which, determine the level of academic patenting. These authors further clarify that there exist two school of thoughts concerning the Bayh-Dole Act, one explaining that this regulation positively affect the output of university patent (Siepmann, 2004), whereas the other is very unconvinced and does not see a need for this IP regulations inside the public research sector (Baldini et al., 2006)

As reiterated by Rhines & Levenson, (2005) the Bayh-Dole Act permits not only universities, but small businesses as well as other non-profit organisations to maintain their inventions to the patents which are realised thanks to the federal funds. As highlighted by these authors, this Act has enhanced the actions of the parties involve and as such has generated many incentives for the research on one hand, and exclusively to the companies who develop this knowledge through licence. Nevertheless, the most outstanding gain to the university is the selling of these patents which generates enough income to further innovate. By considering the idea of triple helix ecosystem, the Governments benefits from the laws as the universities

and companies also carry out employment activities as well as the payment of tax (Miller et al., 2016).

Though on the one hand universities have seen their revenue streams potentially expanding, on the other hand, in the same period, several Countries have been significantly cutting public research funds to the academic system (Rasmussen et al., 2006). A reduction in public funding have also driven universities to seek out alternative and complementary strategies to ensure the financing for their own research (Shane, 2004; Ambos et al., 2008). With the result, especially in some contexts, universities have been pushed to look for additional research streams and for new collaboration opportunities, also with private firms (McAdam et al., 2009). Moreover, most of these firm supported the research of these universities and as such facilitated the collaboration (Feller & Feldman, 2010).

Both the facts – new legislation opportunities and funds cuts – have deeply changed the nature of technology transfer as it was formerly organised and managed in universities and, in turn, in private firms engaging in private-public research collaborations (Bray & Lee, 2000). Furthermore, the evolution of university technology transfer is being experienced up till date as more and more universities are continuously engaging in the field of research, which is transmitted to others through teaching, carrying on further research and transferring this knowledge to other organisations (Etzkowitz, 2013). In general, existing literature seems to converge on the idea that both the parties involved – academia and firms – benefited considerably from an increase of their research collaborations.

Regarding the Chinese context, Chen et al., (2016) recently discuss how Chinese firms in different industries were able to benefit from the technology developed in local universities in the last decade as universities were mostly encouraged to transfer research results to society and assist in economic development. Consequently, it is the developing country that has most dramatically embarked upon building its research universities, partly because there is a belief that these countries will make major contributions to its economic development. Due to its size and visibility, China's investment in university research and deliberate emphasis on technology transfer are of importance, especially since the consent has been that UTT in emerging countries has been unsuccessful (Wu, 2010)

Beyond the opportunities offered by the legislation, there are several reasons why universities and firms started to collaborate closer and closer recently. For sure the disruptive effect exerted by emerging technologies and discontinuous innovations played a significant role in many sectors (McAdam et al. 2009) including health care, financial services, travelling, automotive, energy and many others (Chen et al., 2016).

Considering the higher degree of technological and market uncertainty, some companies found it more convenient and less risky, to co-operate systematically with universities especially those who supported their research (Feller & Feldman, 2010) and, as such, the role that Universities play in the system of producing knowledge has become more central. Despite this collaboration, studies have also shown that the commercialisation of a greater part of university technology in the faculties is done outside the university as some academic researchers side-step their universities and passed technology directly to firms (Lee & Stuen, 2016).

Some studies have shown that when a company develops an innovative idea, it does not directly bring it to market. Instead, the company decides to partner with or sell the idea to

another party, which then commercialises it. Chesbrough, (2007) explains this phenomenon as an open business model which permit an organisation to be more effective not only in the creation of value, but to capture it as well. This author further elucidates why the model should be implemented, w reasons were advanced such as; Value creation by leveraging many more ideas because of their inclusion of a variety of external concepts, permits greater value capture using the key asset of a firm, resource or position in both the organisation's operations and other companies' businesses. Thus, permitting knowledge to pass through a variety of means for its enhancement.

Knowledge exploitation activity passes through many channels: Technology Transfer Offices (TTO) – technical know-how, market insights, research evidence, Consulting firms - or joint research ventures that are opened by Universities with the aim of facilitating the process of technology transfer from university to the market (Siegel et al., 2007; Thursby et al. 2002; Mesny et al. 2016; Slavtchev & Göktepe-Hultén, 2016). As mentioned by Hall et al., (2014), ample knowledge from the universities to the commercial market has been possible thanks to the availability of technology transfer offices (TTO). For instance, in 2005, US universities economic activity produced $40 billion, generating 628 start-ups as well as 4,932 licenses whereas in 2012, the number increased to 705 start-up companies and 5,130 licenses as recorded by AUTM Licensing Activity Survey (Lee & Stuen, 2016).

Meanwhile, Chang et al., (2015) highlight that technology transfer office (TTO) of university has drawn the most attention from researchers in the last two decades. Leitch, & Harrison (2005) found that an efficacy and appropriateness of these TTOs can be involved in second-order spin-out activity and determine potentially the contribution to regional development mainly in the UK. Though Weckowska, (2015) partially shares the same view, this author points out that TTO could constitute a barrier on efficient and actual technology transfer due to bureaucracy (Siegel et al., 2003) or bottlenecks (Litan et al., 2008).

4.2 Applying an open Innovation perspective to UTT

As we already commented, Universities are less and less passive in managing their knowledge assets. According to Cardozo et al., (2011), it was only after the 80s that most universities had the right to own and obtain revenues from inventions that were either entirely or partially developed with public funds. This evolution of the ownership of research by universities is term open innovation since universities could now licence their IP or valorise this knowledge through the transfer of technology to other non-academic institution like firms and companies.

In his pioneering book, Henry Chesbrough, (2003; 2006: 1) defined the concept of open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation". Consequently, according to the author, open innovation brings out a more extensive collaboration and engagement in a wider scope of participants including suppliers, customers, partners, third parties, as well as the community in general with universities becoming friendlier of this trend.

The idea was also shared by Lichtenthaler (2005), where the author describes external exploitation (in other words external commercialisation) as being the deliberate commercialisation of knowledge assets by one organisation to another on a contractual base

usually with an obligatory reward being it in monetary terms or not. Nevertheless, this perspective of open innovation is quite different from the one earlier proposed by Eric von Hippel, (2003), according to whom open innovation refers to a situation in which "all information related to the innovation is a public good non-rivalrous and non-excludable". This author first applied the concept of open and distributed innovation on open source software where he further explained that open innovation includes the right to use the technology at no cost, to study, modify and distribute it to others at zero cost.

However, in this paper we stick to the definition of Open Innovation provided by Henry Chesbrough, who also introduced the distinction between two forms of OI: inbound - which in other word is known as outside-in - and outbound, which refers to inside-out innovation (Chesbough, 2003). While inbound refers to the part of OI involving the opening of the innovation processes of a company to a variety of external inputs and contributions, outbound on the other hand refers to the transfer of unused and underutilised ideas outside the organisation that can be useful to other organisations being it in their respective businesses or business models.

Contrary to inbound, the concept of outbound is not yet very popular and as such still under explored either in the case of industry or in academic research (Lichtenthaler, 2005). Chesbrough explained further that the term OI describes the porous nature of organisational boundaries which makes it possible for firms to interact with their environment in the form of exploitation of external technology acquisition. This author further refers to it as a system that depends on the dynamic capability of the firm being it internally (technology exploration) or externally (technology exploitation) which carries out the main technology management tasks along the innovation process (Chesbrough, 2006).

Consequently, OI involves a while range of both internal and external sources of technology as well as various technological channels of commercialisation. Thus, a deeper consideration of the new managerial challenges in open innovation processes is equally applicable for researchers and practitioners (Chesbrough, 2006). In the same way, OOI is also considered to be an independent commercialisation of IP which is developed from within the portfolio of the firm usually via online with market such as NineSigma (Katzy et al., 2013). As recently explained by Yuan et al., (2018), University technology transfer (UTT) permits universities to extract benefits from their research. Considering it an important method that bring together universities and industries, UTT is refer to as a process that transfer, convert, and commercialise new basic university technology research. This process represents several activities that use resources from the universities to generate value-added products and services for commercialisation, which are later reconfigured with respect to the change in the environment.

Inspired by the work of Henry Chesbrough in relation to private firms, we define University Outbound Open Innovation (UOOI) as the use of purposive influxes and leakages of knowledge mainly from university to accelerate internal innovation and increase the markets for external use of innovation. With respect to this definition, we try to establish the link between the knowledge created by the university and how this knowledge is being transferred to other institutions or organisations with the help of an established market mainly for financial purposes. Thus, this study shall be focus only on technology exploitation which in this case we refer to (in order word) as university outbound open innovation technology transfer (UOOITT)

mainly in the university context and more precisely on the financial benefits of this aspect. In the following section, we shall discuss on the outcomes of the various papers that have made up this review and at the end summarised them into different streams of literature for a better analysis.

4.3 Findings

Table 2 represents the descriptive statistics of the 118 articles carefully selected from 42 different types of journals articles which are used in carrying out this review. However, some classifications which are not represented in this table such as the Theoretical perspective, Methods of analysis as well as the Journal articles due to their magnitude can be found in Appendix 1, 2 and 3, respectively.

Classification variables	**Values**	**Papers**	**%**
Paper type	Empirical	93	78%
	Review	16	13%
	Conceptual	10	8%
Research Methods	Qualitative	71	76%
	Quantitative	20	22%
	Mixed	2	2%
Data Source	Survey	28	29%
	Case Study	24	26%
	Interview	12	13%
	Content analysis	9	9%
	Investigation	9	9%
	Statistical analysis	5	5%
Study Location	North America	46	39%
	Europe	34	29%
	Asia	16	14%
	United Kingdom	12	10%
	Mixed	5	4%
	Others	5	4%

Table 2. Descriptive Statistics of the sample of papers reviewed

With respect to the type of papers used in this review, Empirical papers highly dominate as represented on the table with the highest occurrence (93, representing 78% of the entire papers). In addition, review papers which occupies the second position (16) in the type of papers used, represents 13% whereas the last category of papers is conceptual (10, 8%).

Following the second classification on table 2 which represents the methods of analysis used in this review, the qualitative method dominates with 71 papers which occupy 76% of the entire classification method. Quantitative occupies the second position (20) which is represented by 22% as presented in the table, whereas the case of a mixed method is the least which occupy only 2% of the entire sample.

When considering the data source, it can be observed that a greater part of the data (28) comes from surveys mostly collected through questionnaires constituting the highest percentage 29%.

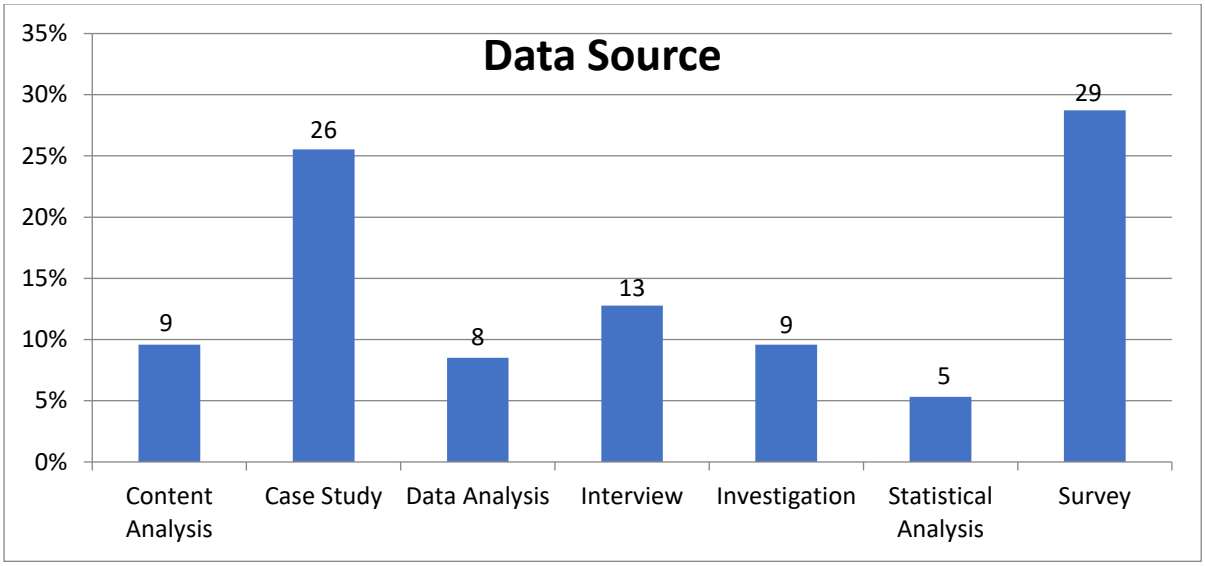

Fig. 2. Classification according to the sources of data.

The second highest source where data was collected according to this review is through case study with 24 studies representing 26% of the entire data source. Also, 12 studies represent data collected through interviews constituting 13% whereas 9, (constituting 9%) of the data is collected with the help of investigation. About 9 studies representing 9% of the research are analysed with the help of content analysis and finally, statistical analysis also represents 5% of the data source, whereas Data Analysis occupies the last position with only two percent of the entire research.

By carefully analysing the location where these studies are carried out, North America comes first with 46 studies which also represents 39% of the entire sample, with over 90% from the United States. Europe occupies the second largest position in the study location which includes 34 studies (29%) with main countries like Italy, Germany France, and some few others.

On the other hand, Asia (16, 14%) occupies the third position in study location with main Countries being China, Japan, and Taiwan, followed by the United Kingdom which makes up 10%. Finally, 5 articles representing 4% comes from a mixed location like UK and Europe and 4% as well from other countries around the world such as New Zealand.

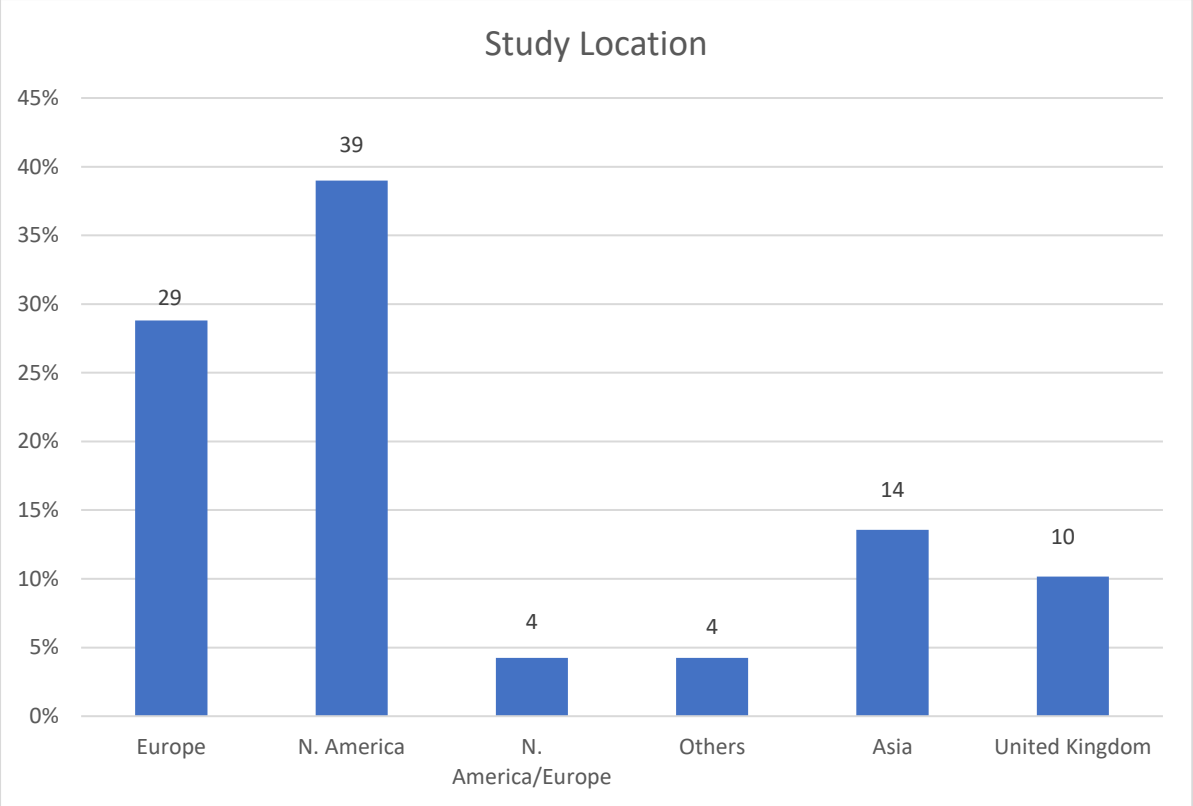

Fig. 3 Classification with respect to location

Concerning the theoretical perspective (Appendix 1), each paper is classified with respect to the theory specified in the paper by the respective authors, though some of the papers did not mention any previous theory used, especially the conceptual papers. According to the theories listed in appendix 1, the first 2 theories were frequently used, with the resource-based view as well as knowledge-based view having a consistent number of studies respectively (7, 18%). This is partly because in some cases, the researcher allocates some papers especially to the first 2 theories which were most frequent in the articles. The third most used theory in this context is Transaction Cost Theory, which was mentioned 5 times, with a percentage of 13%.

Also, Technological change and strategic management theories and Game Theory both occupied the fourth and fifth positions with a 4 (11%) occurrence followed by Stakeholder Theory with 3 articles making up 8% of the entire research. As for the remaining 13 theories used in some of the journal article, each of them frequent only once with each occupying only 3%. (see appendix1).

Regarding the methods of analysis (appendix 2), Regression analysis (20 studies, 21%) is a more popular method among the entire papers studied. Multiple Analysis or methods (16 studies, 17%) which occupies the second position constitutes of those articles where more than a single method is used to analyse data. In addition, 11 of the articles representing 11% each uses both descriptive statistics and Multiple Case Study to analyse the statistical data whereas. A limited number of papers (5 studies, 5%) implemented data envelopment analysis (DEA), whereas Game-theoretic model covers about 4% of the entire studies. Moreover, Revenue Maximisation Model, Semi-Structured Interview and Content Analysis occupies 3% each, meanwhile, the next 4 articles (Meta Data Analysis; Multivariate Probit Model; Market

analysis; Input-Output Model) occupies 2% of the research. although the remaining 12 methods of analysis are less frequent, each of them has a maximum of 1 occurrence representing 1% respectively.

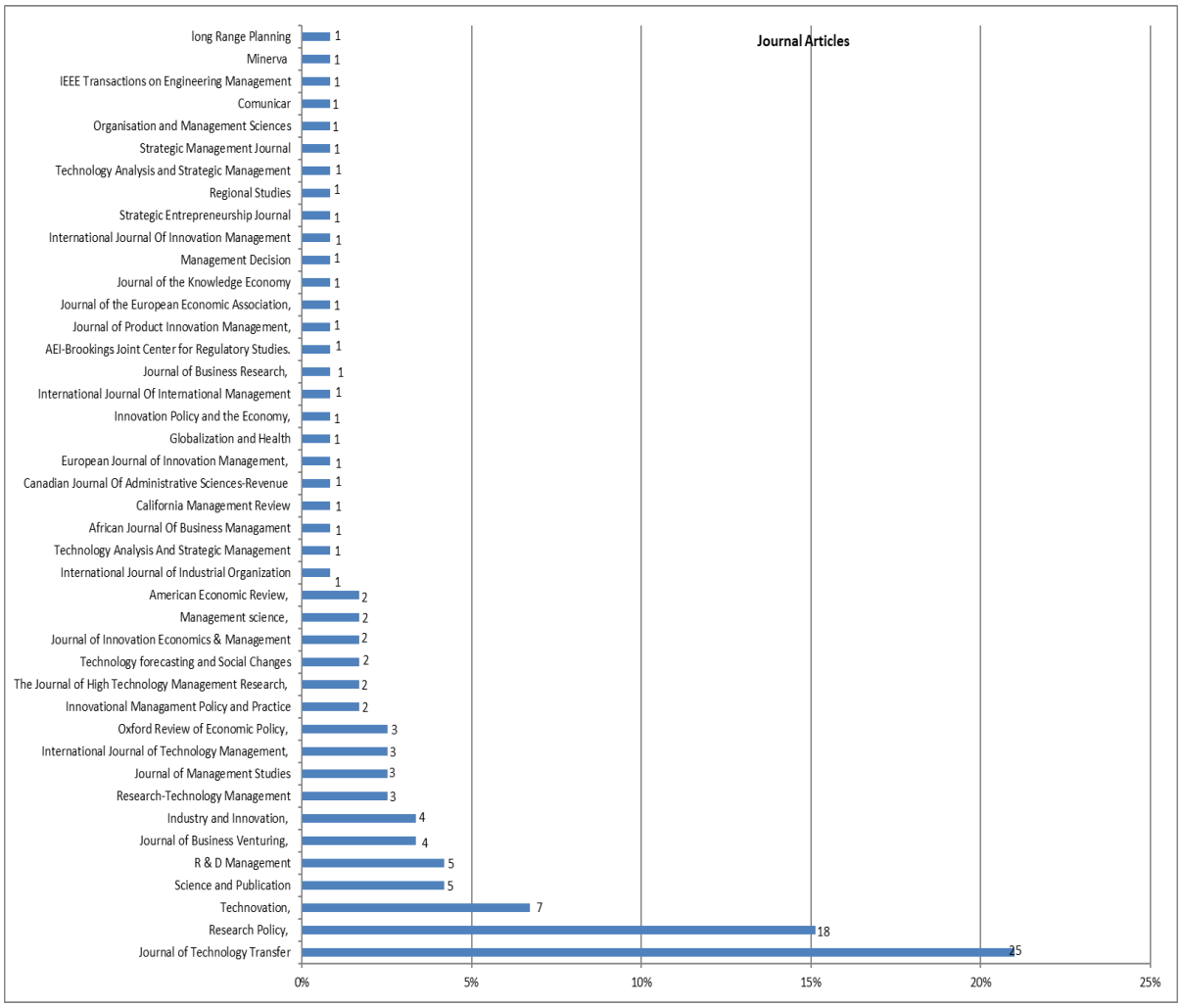

Fig. 4 Number of articles per journal

Considering the case of the journal articles use in this review (appendix 3), a significant part of it comes from Journal of Technology Transfer with 25 articles constituting 21% of the entire papers used in this study. This journal is of great significance to this paper, since it constitutes the basis of the research.

The second most used journal is that of Research Policy which comprise of 18 papers and represents 15% of the selected articles. Technovation on the other hand being the third most used journal makes up 7% of the papers. Also, science and publication as well as R&D Management journals each has 5 articles occupying 4% each of the entire research journals. The next 12 journals contain 4 to 2 articles each making up 30% whereas the last 25 journals are having only 1 article each constituting 18% of the entire journals as can be seen in Fig. 3.

5. Research streams

After reading the articles that were used in this research, they were categorised into four research streams which were generated chronologically with respect to their significance in this research. The idea of coming out with the classification of the four streams was not based on any prior literature but on the results of my personal interpretation. This was done after carefully reading the abstracts, introduction, methodology as well as the conclusion of the papers involved. Here, it was realised that the papers (though explained similar views) had different focus. This classification was done to bring out the main idea of these papers so that at the end we shall know the categories of papers we are dealing with. This classification will also help us to know if there has been an evolvement in any of the streams which could subsequently be analysed. The four streams involved in this research have been named as follows:

- Knowledge transfer modes and intermediaries: These papers focus on the variety of ways through which academic inventions can be transferred to users, being it either through intermediaries such as the technology transfer offices (TTOs), University Incubators (UIs), and Collaborative Research Centres (CRCs) or through main channels including licensing, patenting as well as creating spin-offs. These papers occupied a greater percentage (35%) of the research articles.

- Strategy, organisation and management: In this case, we identify some articles that made mention on how the institutions administers and achieve their inventions and some of the strategies put in place by these institutions to manage the intellectual property rights. Papers in this category occupied 25% of the entire research.

- Economic and social impact: Here, some papers are sorted out that mainly centred on the price or monetary value that is generated in academic inventions due to their expansions and partnership with different scientist or institutions. This involve the benefits not only to the university, but also enterprises and the society at large which create a network of values and growth. The papers in this section covers 18% of the entire research.

- Internal impact: By this, we classified some articles which explain the positive outcome of this innovative research including the performances and the successes recorded being it through technology transfer or collaboration (usually with Government for social benefits) making up 22% of the entire research articles.

While classifying these articles into the above research streams, it was discovered that some papers made mention of issues concerning other research streams, however, note was taken on where the authors laid more emphases. The research streams might somehow look similar, but detailly they centred on one of the above streams. Also, the citations were gotten with the help of google scholars, which also shows that a greater part of the papers have been cited by other scholars making the articles to be useful for this research. These streams shall be more elaborated in the following paragraphs. It is also worth mentioning that about 80% of the 118 papers were used in the research streams below which permitted us to see the clear

difference of the articles, also because some of the articles were highly similar and could hardly been streamed differently.

5.0 Research stream 1: knowledge transfer modes and intermediaries

The first stream is also considered as the first chronological as it is aimed in previous articles at examining as well as analysing the various methods and intermediaries necessary for transferring the knowledge generated by universities into different facets of the society and more especially licensing and commercialising the new inventions. Selected articles in this stream are represented in table 2 which briefly states the authors involved and their year of publications, the citations of the articles gotten from google scholar in October 2017, the method used in collecting data as well their main ideas and contributions.

It is generally argued that open innovation practices can be predominantly useful in moving technology off the shelves, mostly in cases where potential user community is small, disjointed, or not well linked to the sources of university research. Most authors have thus drawn their inspiration from the pioneer work of Lichtenthaler, (2005) where the author first mention the idea of technology commercialisation. According to Hall et al. (2014), University research has long been considered as being the main source of possibly useful knowledge which has been commercialised in markets thanks to technology transfer offices. The author took an example of US universities that made $40 billion in economic activity in 2005, which led to the creation of 628 start-ups and 4,932 licenses and elsewhere in 2012, 705 start-up companies and 5,130 licenses were generated in this US as reported by the AUTM Licensing Activity Survey.

In addition, Weckowska, (2014) and chang et al., (2016) explain that these technology transfer offices have for over the past two decades drawn the attentions of researchers, since most of the university's revenue accrues from the disclosure and licencing of their inventions to these offices. As explained by other scholars, most businesses are well informed in recent years thanks to the growth of university technology transfer offices couple with the enactment of the Bayh-Dole act (Thursby and Jensen, 2001).

Although, Thursby et al., (2009) acknowledge the fact that these offices have experienced an enormous growth in university licencing after the enactment of the Bayh Dole Act in the 80s, 26% of the patents generated in the US by universities were allocated rather to firms. According to them, this proportion was even greater in Canada and elsewhere in Europe. Also, in recent years, there has been an increase in the transfer of university technology and commercialisation usually with help of licensing agreements (which is said to have increase due to a rise in the overall university resources), university start-ups as well as joint research ventures (Thursby et al., 2002; Mesny et al., 2016). With an outstanding lead from the United States, most universities worldwide have now engaged in the creation of technology transfer offices for the commercialisation of public research from organisations. Thus, this has encouraged most researchers to contribute by commercialising the outcome of their research (Mesny et al., 2016).

Chatterjee and Sankaran, (2015) on the other hand highlight that the model of university technology transfer is understood here as technology seller pooling inventions from numerous research laboratories found in a university. These authors further considered the University

transfer offices as a model of technology transfer from the university to industry, which is instrumental in emerging and building up of a lasting and reputable relationship across industries that could not be performed by a single lab. Though with the collaboration of industries, entrepreneurship amongst faculty members and other means of commercialising academic research has become more significant in recent years. Likewise, some universities in Asia (Malaysia, India and Thailand) have not actually benefited from the scheme as they still consider teaching as the fundamentals with little or no interest in the commercialisation of research, patenting as well as relations with industries (Chatterjee et al., 2015).

Moreover, Rasmussen et al., (2006) is of the view that technology transfer can be effectuated and more effective if the university focuses on entrepreneurial activities, licencing and even the creation of spin-offs rather than engaging on more general and diverse relationships or cooperation with industries. These authors focus on knowledge commercialisation in the intellectual property right of the university which as well generate greater economic development and performance.

Raine and Beukman, (2002) also confirm that most universities transfer their technology through the commercialisation of their intellectual property rights which results from the research carried out to businesses and industries. This is due to the reduction of funds provided by the government, and as such universities must look for other means to generate income and as well share the profits with these organisations. Carayannis, (2015) highlights that the commercialisation of technology can be interpreted as any form of commercial usage of the intellectual property. According to the author, this action can be carried out through licencing, venture formation or when the university internally uses the intellectual property (right to sell or licence) which is later commercialised by specialised companies (Giuri et al., 2013).

Furthermore, commercialisation emerges new functions such as business incubator, creating new companies (start-ups), executing innovative projects and then licencing (Kirchberger & Pohl, 2016). Thus, technology from the university can easily be taken to the market thanks to the combination of the above and other channels being them formal or informal working together (Kirchberger and Pohl, 2016; Özel and Penin, 2016). Additionally, commercialisation of technology resources does not limit itself only to the selling of own products or services but extends beyond the conversion of such approaches including means such as patent selling, technology spin-offs, licensing also technology induced tactics (Kutvonen 2001; Lichtenthaler, 2005).

According to Wu (2010) licencing and patenting are the most effective ways through which technology can be transferred from universities to other entities. The author referred to these research universities as technology transfer vehicles which convert scientific inventions into innovations usually through licencing and patenting of the research production. In addition, Swamidass (2012) explains that a start-up may be the only and if not the best opportunity for the commercialisation of over 70% of the total inventions which a university generates and are never licensed to be commercialised by business units. Experience, as highlighted by the author shows that many university inventions remains on the shelf if they are not licenced to start-ups and as such is of no benefit.

This view is supported by data from the (Association of University Technology Managers) AUTM, which reports that from 1999 to 2007, about 30-35% university licences were allocated to large companies, 50-55% to small companies and 10-15% to start-ups. Pries and Guild

(2011) on the other hand examines how commercial uncertainty, specialised harmonising assets, technological dynamism as well as other legal protection affect the choice of business models. Also, the idea of academic engagement and commercialisation is clarified in this review in that the former consist of traditional academic research activities which access useful resources to support the research agenda (Perkmann et al., 2013).

Considering this relationship, most pharmaceutical companies use as strategy not to licence their products in areas where the capacity to develop these products are low, for instance in some parts of Asia and Africa. It is also said that the very fundamental line of strategy of a university after putting the invention in the commercial market is to look for already established companies either in the same field of study or in related fields. That is, those that have the capacity to transform the newly developed invention or technology or knowledge into either research and developments or a prevailing line of products or better still using this new tech to develop a new product (Graff et al., 2002).

Authors	**Cit.**	**Article method**	**Articles focus and contribution**
Hall et al., (2014)	14	Interview	Effectiveness of commercialising university research considering the diverse markets. Contribute to developing manager's awareness of the activities of the research community and monitor research developments.
Chang et al., (2016)	6	Conceptual	Faculty disclosure and selection of commercialisation mode. Contribute to the existing literature on the impact of patent disclosure
Lichtenthaler U., (2005)	214	Review	The commercialisation and exploitation of external knowledge and its consequence. Contribute in assisting managers to assess the utility of new approaches
Thusby and Jensen, (2001)	5	Survey	the reduction of federal funded research due to non-license of university patent. contributes to the empirical literature on the industrial impact of university research.
Chatterjee and Sankaran, (2015)	6	Interview	Variation of commercialisation with respect to definitions and orientations. how learning occurs in TTOs, and how the learning processes involved shape learning outcomes
Weckowska, (2014)	39	Conceptual	Capacities needed by University Technology Transfer Offices (TTOs) to facilitate commercial exploitation of research outputs. Contributes to novel conceptualisation of occurrence and processes of learning in TTOs, and shapes commercialisation practice.
Rasmussen et al., (2006)	372	Case study	An expected increase in both University' R&D and commercialisation knowledge. Contributes to university responsiveness to the new role of commercialisation
Özel and Penin, (2016)	0	Review	The determinants and welfare implications of university intellectual property patenting and licensing strategies. Contribute more to economic development through TTOs.

Raine and Beukman, (2002)	22	Content analysis	The role of university-industry liaison offices in commercialisation process. Contributes to the valorisation of universities as well as industries.
Carayannis et al., (2015)	12	Content analysis	The practices, directions and tasks of technology commercialization and licensing at the University of Maryland (U.S A). Contributes to demonstrating mechanisms of the optimise and substantiate decisions concerning licencing contract.
Mesny et al., (2016)	2	Case study	The commercialisation of academic output in the administrative science. Contributes to the harmonisation of scholar's practitioners and the knowledge used.
Kirchberger and Pohl, (2016)	10	Review	The systematic review of current literature on technology commercialisation. Contributes to providing a comprehensive and systematic overview of the current literature on technology commercialization channels to provide a better understanding of the factors that have already been researched in this field.
Pries and Guild, (2011)	64	Survey	The analysis of model to be used by universities for commercialisation. when intellectual property protection is weak, a technology sale business model approach to commercialisation is appropriate.
Wu, (2010)	55	Survey	Analysing the influence of successful licensing of university patents. Contribute to the complex reasoning and historical legacies underlying university decisions.
Swamidass, (2012)	33	Case study	The persuasion of appropriate polices to generate more university start-ups for technology commercialisation. Contributes to advancing procedures and standardised agreements for easier licensing of university inventions to start-up enterprises
Graff et al., (2002)	117	Review	The business of technology transfer between universities and firms. Contributes to establishing unique research units that are quite unique in their capabilities and that have distinct relative advantages in terms of capacity and cost effectiveness.
Giuri et al., (2013)	23	Survey	Commercialising academic patents, developed in both universities and public research organisations (PROs). Contributes by investigating if ownership of a patent affects the eventual prospect of commercialisation, comparing the commercialization outcomes of university/PRO-owned and university/PRO-invented patents by exploiting an extensive data set that spans multiple countries and commercialisation consequences for university/PRO patents in countries branded by different IPR legislative systems,
	661	Review	

Perkmann et al., (2013)	265	Survey	Academic engagement and commercialisation of University - Industry technology transfer. Contributes by providing the first review, synthesising empirical results into theoretical framework, and showing how academic engagement, which uses methodological approach differ from commercialisation.
Thursby et al., (2009)			Assignment to inventor-related start-ups is less likely and higher than the share of revenue inventors receives from university-licensed patents. Contributes to policy viewpoint by sharing revenue from licensing that accrues to the inventor when inventions are assigned to and licensed by the university.

Table 3. The above citation counts are gotten from Google Scholar in October 2017

5.1 Research stream 2: Strategic, organisation and Management

Following the second research stream (which is considered according to previous research as the second stage of technology transfer), the academic research generates institutions which organise and manage the various faculties involved in this sector. The management at this stage is not only limited to the faculties, but as well the different actors involved such as industries, government and other third parties. This stream also makes mention of the various strategies implemented through which technology transfer and exploitation is carried out, also how it is done. Some authors have based their studies in analysing how the knowledge generated by universities is manage and the proposed strategies used in transferring this knowledge represented by table 3. An example is highlighted by Keupp et al., (2012), where these authors explain that strategic management of information is the use of strategic management techniques and measures to enhance the innovative activities of firms and ensure it growth and performance. In recent years, Technological knowledge is becoming the foundation to maintain competitive advantage not only for high-technology industry firms, but also to some universities that carries out innovative research.

As mentioned by Bianchi et al., (2011), the main issue in strategic management of technology is the conversion of technical knowhow into an economic worth. According to the author, this phenomenon can either be carried out internally through the combination of various technologies or knowhow into useful service which can be marketed or by the direct selling of these innovations themselves which is an external factor. In recent years, most universities are carrying on more entrepreneurial roles mainly as key players in the ecosystem of regional innovation with an outcome of technology transfer (Miller et al., 2016). This phenomenon is usually termed the triple helix ecosystem which involve the interaction between universities, industries as well as the Government resulting to the growth. On the other hand, the diversity between stakeholders in knowledge transfer generates some cultural and institutional differences possible to affect the smooth acquiring, transforming as well as the exploitation of external knowledge (Miller et al., 2016).

According to West, (2008), most technical knowledge after the second world war was managed through the condition and protection of intellectual property rights which were later licenced

by universities to most firms either as equity payments or in cash. Litan et al., (2008) on the other hand explain that, one of the ways through which university manages their inventions is through knowledge spill over also known as the process of university–industry technology transfer (UITT) (Chang, 2016). This spill over as mentioned by the author accurse either by distributing the knowledge in the process of peer review or dispersing graduates into labour force. Spill over in this perspective implies that the resource changes from private gain in to public good which intend provides vital contributions to the growing inventions and licencing of other researchers as well as the research and developments of some industries (Chesbrough, 2003; Lach & Schankerman, 2004).

Also, universities have for over the years plaid a significant role in in knowledge transfer across the pharmaceutical industries due to their collective nature of operation. According to Chaifetz et al., (2007), this has given them stronger negotiation position regarding other players in the field since university processes rights permits them to hold key components of different end products. As explained by Ismail et al., (2011), the recommendations for most universities from the National Research Council (NRC) stated that these academic institutions should implement new strategies to boast the development of new university start-ups capable of commercialising the inventions which might not have been taken off the shelf. Thus, universities need new technology transfer policies which can permit them to regularly evaluate their inventions to meet up with the recommendations from the NRC.

Payumo et al., (2012) suggest that research and development aim at educating future workforce as well as conducting a balance program on applied, basic and experimental development research. According to them, this gives an opportunity for universities to search for new and better ways of financing their research activities. They emphasised that these tools are not familiar in the less develop countries and as such, with a detail understanding of the management roles and the process of technology commercialisation, it is a good target for institutions seeking to advance their capacity.

Conceic et al., (2013) also argued that the type of commercial market to target by universities refers to the strategic decision on the transformation of knowledge in monetary value. This is so because, some knowledge or technology that are invented in some universities needs to target selected markets. Likewise, university can as well manage its strategy by maintaining a close relationship with scientific industries as well as externalising its outstanding technology (Macho-stadler et al., 2007; Kutvonen, 2001). Moreover, new academic institutions as well as organisations are being developed to realise scientific research and innovations in a faster way through a better management of incubators, technology transfer offices and science parks (Libaers, 2014).

authors	Cit.	Article method	Articles focus and contributions
Bianchi et al., (2011)	19	Case study	The challenges of technology sales and the management of the complexity of technology transition. Contributes in

			the development of managerial solutions to the challenges from technology sale.
Lach & Schankerman, (2004)	160	Case study	The variations in royalty sharing arrangements across Universities. Contributes to giving more attention to the university sectors and their designs.
Miller et al., (2016)	22	Interview	The aspect of knowledge transfer from Universities to other stakeholders throughout licencing. Contribute to emergence of the knowledge economy combined with the growing complexity and role of end users as a core stakeholder within open innovation processes.
West, (2008)	38	Content analysis	Analysing different processes of knowledge spill over from universities to industry. Contributes by significantly improving communication applications through the theory of information building up a stream of research in open science.
Chaifetz et al., (2007)	14	Descriptive	The influence of University research intellectual property to close the gap for health innovations in poor countries. Contributes to the adoption of Equitable Access Licence by universities and public sector to proactively avoid obstacles to the production of basic medicine.
Chang, (2016)	6	Interview	The decisions in faculty invention disclosure towards commercialisation mode in its invention. Contribute on the commercialisation of university-invented patents in a more comprehensive process of UITT and on the impact of patent disclosure.
Ismail et al., (2011)	18	Survey	The Business Models permitting to transfer inventions from Academic to Commercial. Contributes to the creation of semi-conductor diode laser for Xerox printer business.
Chesbrough, (2003)	2309	Case study	The need to make important investment decisions to ensure the future. Contribute to the synthesis of open innovation into new paradigm for managing corporate research as well as carrying new technologies to market.
Kutvonen, (2001)	56	Review	Measuring outbound open innovation (OOI) by identifying strategic objectives for external knowledge exploitation. Contributes by considering outbound open innovation as an enabler of additional strategic mobility and flexibility.
Macho-stadler et al., (2007)	185	Theory	The role plays by technology transfer in universities. Contributes to characterising empirically the correlation between technology transfer offices and revenue from licencing.
Payumo et al., (2012)	10	Case study	Presenting different IP and technology commercialization policies and lessons learned to offer options, to public research institutions. Contributes to understanding how

Conceic et al., (2013)	44	Interview	government funding works in different institutions when commercialising IP technology
Libaers, (2014)	8	Survey	Analyses of decisions regarding the commercialisation strategy of research based. Contributes to recent work by determining the commercialisation strategy of technology-based SMEs Managing the interactions characterising foreign-born academic scientists with private firms. Contributes to the literature stream on foreign-born academic scientists in the framework of university–industry interactions.

Table 4. The above citation counts are gotten from Google Scholar in October 2017

5.2 Research stream 3: Economic and social impact

With respect to this stream of research, some articles represented in table 4 discussed on the value that these inventions create not only for the university, but to the society at large through internal and external network, respectively. In this section, a greater part of the authors emphasised that the economic growth is because of the value network created by these academic institutions mainly universities through the interaction with either scientists from other institutions or industries, organisations as well as the Government.

Financial value or knowledge is also generated either through licencing or creating spinoff, incubators, or university technology transfer offices both home and abroad and as such creating a long-term network within universities and other corporations. As Regions and nations around the world are progressively faced with key economic challenges, they seek ways to enhance their chances of economic growth. Consequently, it is significant for legislators to better comprehend the part played by the university in the creation of value in the economy (Roessner et al., 2013).

In recent years, the government is making good use of knowledge generated in academic institutions through the valorisation and fostering of innovation as well as encouraging competition in the knowledge-based economy (Chang et al., 2008). furthermore, the bridge of the networking system by policy makers in the creation and utilisation of academic knowledge by companies greatly influence the value created in this sector and could be detrimental to economic growth of the country involve. Prior research has thus accessed the implication of academic spin-offing, patenting, licencing regional economy and the implementation of the bay-dole act on market orientation in addition to the value generated from these actions (Thursby and Thursby 2002).

Chang et al., (2008) on the other hand highlight that much value has been created in academic institutions thanks to the flourishing of the intellectual property rights, spin-offs, incubator as well as licencing of technology transfer. In addition to the above, the Bayh-Dole enactment in the US in the 80s has been a source of inspiration to some Asian Countries mainly Taiwan, Japan and Korean where they also endorsed the Science and Technology Basic Law (STBL) permitting the ownership and management of IPRs in academia which have let universities

now to be in full control of their Intellectual property. This accelerated the commercialisation of new technologies while promoting economic development besides entrepreneurial activity. This has also formed new links with other organisations to create and operate on the same platform.

However, Mowery et al., (2001) point out that some universities such as the university of California and Stanford had recorded successes in technology licencing even before the passage of the laws which according to them has had little influence on the content of academic research. This is because, these universities were large-scale patentors who have established strong relationships with already well-established institutions and organisations thanks to the government expansion efforts in gaining robust international protection for intellectual property. Also, the constant increase in productivity of research and development is due to the research-related activities namely the development of new university technical know-how, the provision of valued human capital for both faculty and students which has greatly enhanced the growth of national economy (Roessner et al., 2013).

The growth in the academic research commercial output has considerably drawn the attention of both the managers of technology and university administrators for over the years, who valorised this phenomenon by consistently engaging in commercial activities. This has led to some changes in business behaviour towards universities. Thus, increasing the contribution of economy growth (Thursby et al., 2002). In addition, the social, political and economic aspects have significantly influenced the ability of university to economically develop and organise knowledge useful to the society and as such, contributing to both the success and economic growth (Bercovitz and Feldman, 2006).

Furthermore, there has been a shift from traditional to a more advanced, protected, and wider approach by considering patent as a sellable asset which can obtain a licence and generate enough money out of the academic institution through commercialisation. Studies have shown that over 40% of US patent holders account for about 99% of the entire revenue generated by US licencing whereas the remaining 1% of revenue from licence comes from 60% of the patent holders leading to the paradox that out licencing is still relatively low in this area (Ziegler et al., 2013).

Besides, education as explain by some authors is one of the oldest academic activities that contribution to economic growth as these institutions also takes into consideration the commercialisation time of their technology (Carree et al. 2014; Markman et al., 2005). University administrators have constantly cited UTT as a catalyst to the regional economic growth or development due to the revenue it generates in contemporary economic environment. As a result, some universities have experienced a drop, in funding from both Government and other organisations (Friedman and Silberman, 2006). Moreover, Higher Education Institutes (HEIs) have for some time played an outstanding role in the continuous generation of economic value through regional development as well as the creation of employment in the economy. Much attention has also been given to knowledge generated from the university, since it is geared towards economic growth and technology innovation. Consequently, increasing competitiveness and national successes (Chang and Yang, 2008).

Because Universities have for some time now contributed significantly in the value creation of regional economic growth (through the conversion of scientific inventions to innovation with the help of some specific instruments mostly licencing and patenting and research output), it is thus necessary to further examine the influences of the growth in the licencing of these university patents (Wu et al. 2015; Litan et al., 2007). Beside training young minds, transmitting culture and generating knowledge, universities also act as a mediator in economic growth (Cardozo et al., 2011). Additionally, there has been an enormous encouragement by some universities in the search of alternative means through which their technology can be commercialised which thus led them to the development of spin-offs companies with the aim of generating more money. This is so because, these universities can easily obtain equity in the creation of start-ups to commercialise their technology than selling the license to an already established company (Bray and Lee, 2000).

author	**Cit.**	**Article method**	**Articles focus**
Ziegler et al., (2013)	17	Case study	Value capture through the commercialisation of Intellectual Property (IP). Contribute to the implementation and deliberations on the structure of IP commercialisation by universities and firms.
Carree et al., (2014)	39	Case study	The transformation of academic knowledge into regional economic growth. Contributes to transforming the outputs of new ventures into enhanced performance.
Chang et al., (2008)	10	Survey	The influence of university's IPR management and external research partnerships on creating income through patenting and licensing. Contribute to the enhancement of policy implementation in the national interactions of the triple-helix.
Mowery et al., (2001)	1518	Content analysis	The growth in university patenting and licencing resulting from the introduction of the Bayh-Dole Act. Contribute to presenting the comparative analysis for academic research enterprise and the innovation system of U.S.
Chang and Yang, (2008)	32	Case study	knowledge generated from university gears towards economic growth and technology innovation. Research exploitation. Contribute to managerial and attitudinal changes between academics regarding the collaborative projects of university–industry
Roessner et al., (2013)	44	Case study	Contributions made by university licensing to the national U.S. economy. Contributes to increasing productivity in industry resulting to university technology growth and new knowledge generated.

Thursby and Thursby, (2002)	954	Survey	Analysing the dramatic increase in university technology transfer through licensing. University contribute to economy through substantial attention of academic research from both university administrators and technology managers.
Thursby et al., (2002)	580	Survey	The increased in licensing for reasons other than increases in overall university resources. Contribute to proposing reasons and analysing factors associated to the shift of university to a more productive commercialisation level.
Bercovitz and Feldman, (2006)	638	Conceptual	Enlightening the role of universities in systems of innovation. Contribute to social governance and development of relations at work and economic efficiency of absorbed knowledge.
Bray and Lee, (2000)	33	Interview	The success of incubators or University parks depends on how much technology is transferred from their labs to start-ups. U.S. universities contribute data to both equity sales and holdings.
Chang et al., (2008)	10	Survey	The adaptation of the new international IRP Regulations (passed from 1962 – 2002) by Italian Universities. Contribute to the rapid development of novel high technology firms in the U.S. economy during the 90s.
Markman et al., (2005)	386	Case study	The slow rate of technology transfer and its impact on economic growth. Contribute to the debate by policy makers for a shift from applied to basic research.
Cardozo et al., (2011)	30	Survey	Using commercialisation time of patent-protected technology as a means of speeding innovation. Contribute to the understanding of the present and future evolution of the UTC.
Litan et al., (2007)	49	Review	The introduction of the Bayh-Dole Act in the 80s and growth of University innovation commercialisation. Contribute to maximising the potential for university-based inventions resulting in the commercialisation of new innovations and products.
Friedman and silberman, (2006)	657	Empirical	The increasing importance of University technology transfer activities are increasingly important as a source of regional economic development and revenue for the university.
Wu et al., (2015)	44	Survey	Determining the likelihood of individuals and institutions through the licencing of university patent. Contribute in providing new insights to

	licensing into the process of commercialising university inventions.

Table 5. The above citation counts are gotten from Google Scholar in October 2017

5.3 Research stream 4: Internal impact

Considering the research carried out by Han and kim, (2016), most previous studies on technology transfer have shown great performances relating to the characteristics of numerous universities including the existence of university TTOs and as well the type of university involved. In addition, a few former researchers have revealed the relationship existing between technology transfer performance and the Bayh–Dole Act which was created to enhance university innovation. Nevertheless, there exist many stakeholders in academic research institutions (namely, managers of technology licensing offices, faculty, and administrators) with diverse perceptions on commercialising research which according to Kim and Daim, (2014) makes it difficult to measure the performance. However, further research suggest that institutions should compare their practices with others by measuring the productive efficiency of licensing practice and benchmarking studies (Anderson et al., 2007; Thursby and Kemp, 2002).

The performance of university in the transfer of technology seems greater when the scientist of the university work alongside those of the biotechnological firms which increases the tacit knowledge of the academic institution (Zuker et al., 2002). The case of China is mentioned here as a good example where academic research performance in technology transfer has for over the years witness an equivalent increase with the West resulting from a pollination of the two research communities (Chen et al., 2016).

Despite the economic benefits emanating from the valorisation of university technology transfer, some countries such as the Netherlands do not seem to benefit from this scheme. This is because due to the limited data provided by the Dutch universities, research from these institutions cannot come out with clear results regarding their performances (Vinig and lips, 2015). In addition, these authors considered technology transfer as a broad and unmeasurable term. For instance, though the presents of variety of stockholders makes performance to be measured by the monetary income generated from universities, it does not still measure the real performance. This is because it does not offer potentials for technology transfer that rely on university research. As such, technology transfer with a high dollar income could have a low performance considering that fact that what represent the dollar income is lesser than the available potential.

According to Caldera and Debande, (2016), enhancing the performance of university technology transfer greatly draws the attention of most policymakers and as such permitting them to better administer their research activities in the respective institutions. These policymakers being them in the state or national government also regards the growing research in universities as a catalyst of economic growth which intend triggers the performances of these institutions (Chapple et al., 2005). To effectively measure the performance of the research carried out in an academic institution, if possible, universities should sustain completely the characteristics of this process which ranges from inventing, innovating, commercialising and

transferring of the new technology (Litan et al., 2008). Despite all this, there has been little analysis with respect to the efficiency in the system of university technology transfer. In analysing the US university performances, it was realised that this greatly varies from one university to another due to the number of licences, the formation of spin-offs as well as the income generated from these licences (McAdam et al., 2009; Siegel et al., 2007).

As explains by Calcagnini and Favaretto, (2010), time is the most important factor when considering the internal impact of the university knowledge invention. This author applied the innovation speed theory and came out with two assumptions. Firstly, the performance of an academic institution is greater if the commercialised knowledge could further generate revenue through licence or create new venture, also if the university can identify what determines the speed of its innovation. Apparently, universities could become more flexible in negotiating their licence agreements which could be absorbed by other firms. As highlighted by Seiegel et al., (2003), the capacities of university TTOs partially determine the performance of university commercialisation since not all results from university research is being released to these transfer offices.

This however simplifies the academic invention exploitation in the application of commercialisation since not all researchers have interest and ability to move forward potential commercial applications of their research (Chapple et al., 2005). In addition, the increase in performance of university technology transfer can be evaluated either by profits portraying a more diverse goal or through the identification of some new potential partners either by creating incubators or new ventures to commercialise the exploitation of academic inventions, securing the intellectual property rights as well as evaluating technological inventions (Chen, 2009 and Thursby et al., 2001).

Investigating the relative efficiency of U.K. University technology transfer office (TTOs). Contribute to presenting the first empirical evidence on the relative efficiency of U.K. universities and comparing parametric and non-parametric approaches to productivity dimension.

Authors	Cit.	Article method	Articles focus and contribution
Han and kim, (2016)	0	Multiple source	Elaborating on the determinants of technology transfer in the universities in Korea. Contributes to the creation of new firms resulting from the ineffectiveness of patents.
Caldera and Debande, (2010)	178	Investigation	Investigating the role of policies on performance. Contribute to appreciating university technology transfer through the investigation of policies role on performance.
Chapple et al., (2005)	428	Case study	Investigating the relative efficacy of U.K. university technology transfer office (TTOs). Contribute to presenting the first empirical evidence on the relative efficacy of U.K.

			universities and comparing parametric and non-parametric approaches to productivity dimension.
McAdam et al., (2009)	23	Case study	Means for improving the commercialisation of University technology transfer using an Absorptive Capacity perspective. Contribute to the modern evidence affecting university technology commercialisation and using Absorptive Capacity as an interpretive outline in this context.
Calcagnini and Favaretto, (2016)	5	Survey	Innovation leaders perform better than economies with low levels of innovation investment and institutions that do not favour knowledge and technology transfer activities.
Siegel et al., (2003)	729	Interview	The analyses and outcome of university –industry technology transfer (UITT) process. Contribute to improving the consideration of UITT so that the managers of the process in universities and industry can enhance its effectiveness.
Siegel et al., (2007)	374	Review	The increase in commercialisation rate of intellectual property at US and European universities has important performance and policy implications. Contribute assisting policy makers and practitioners in organising TTO for better performance.
Thursby et al., (2001)	750	Survey	Relationship between licensing outcomes and both the objectives of the Technology Transfer Office (TTO) and the characteristics of the technologies. Contribute to literature by providing evidence of universities on their purposes, in addition to a new indication on the type of inventions licensed.
Kim and Daim, (2014)	5	Survey	Ways to identify time-lags in the licensing process. Contributes to measuring the performance of licensing of U.S. research institutions by suggesting a method for recognising time-lags in the process of licensing.
Chen et al., (2016)	4	Review	Outlining and evaluating the state of research about university technology transfer in China. Contribute to a deeper understanding of the advanced discussion in China as compare to other nations.
Chen, (2009)	172	Case study	The effects of technology commercialisation incubator and venture capital. Contribute to intermediating the effects of Technology Commercialisation capacity and the moderating effects of incubators and venture capital support on performance.

Vinig and lips, (2015)	13	Annual report	Measuring empirically the performances of Dutch university's technology transfer. Contribute to the literature on university technology transfer by adding a new approach to measure its performance.
Anderson et al., (2007)	284	Conceptual	Evaluating public versus private universities in terms of procession of medical schools. Contribute to technological changes in definite subfields of nanotech.
Thursby and Thursby, (2007)	164	Survey	Analysing the success of growth in university technology transfer through licensing. Patent system Contribute in motivating inventors to disburse resources in risky innovative activity.
Litan et al., (2008)	91	Review	Progress made in innovation practices from the 80s and the prospects. Contribute to improving the human condition, thus aiding the transfer and commercialization of findings attends the inventor and society interest.
Thursby and Kemp, (2002)	581	Survey	Examining the overall productivity of university licensing activity as well as the productivity of individual universities. Contribute to measuring the success of a university's technology transfer.
Zuker et al., (2002)	1132	Content analysis	Analysing university tacit knowledge transfer to firms. Contribute to recommending affordable bibliometric measures which are better but then not perfect substitutes for the costly-to-construct star measures.

Table 6. The above citation counts are gotten from Google Scholar in October 2017

6. Discussion of our findings

Although nearly all universities carry out technology transfer activities, the distribution of successful commercialisation activities is highly skewed among universities whose TTO sometimes do not really benefit financially as anticipated (Litan et al., 2007). The question of why some universities perform more than others has been approached by quite a lot of authors for over the years with reasonable answers some of which are either involving the general commercialisation activities (Rasmussen et al., 2006), or for other methods of commercialisation put in place by some universities for example licensing or spin-offs and patenting (Siegel et al., 2007). This is to say that some universities own specific structures or carry out variety of activities that others do not such as operating UTTO, Research incubators, spinoffs, among others.

with respect to the research streams, it was realised that a greater part of the authors (35%) mainly based their research on the commercialisation modes where these researchers expresses the deficiencies in developing this sector of the research. According to this stream of research,

the authors try to identify what modes of commercialisations could be better administered by universities worldwide to benefit more financially from their inventions. Some of the modes identified in this stream were through the issuing of licencing (which forms the bases of this research) by universities, the creation of stat-ups and technology transfer offices which have in recent years witness an increase since most corporations also uses these offices to market their new technologies. Also, the creation of research incubators has facilitated invention and commercialisation of university knowledge there by enhancing the transfer of this knowledge to other institutions or organisations. Thus, given these research modes universities around the world can carefully study and select the commercialisation mode that best describes their objectives. As such, the benefits accrued to such universities permit them to cover the cost of research and encourage the institutions to further its research in new fields of studies.

Furthermore, about 25% of the entire research papers discussed on the strategies as well as how their inventions are being managed during licencing. In this stream, some researchers concluded that for a university to succeed in taking its research off the shelves, this university needs to implement better and new strategies such as enhancing the existing faculties for a better production or creating new institutions as earlier mention. These strategies can be better implemented or administered by managing the various outlets (TTOs, spin-offs, incubators) so that the university can successfully commercialise the invented technologies. This is also a chance for university administrators to bring in well skilled managers or researchers who have the potentials to get the research off the shelves into the market.

In addition, almost 18% of the articles focused on the economic and social impact which is considered as one of the goals of each university engaged in the commercialisation of research. As explained by most authors, the aim of carrying out research in universities is to take it into the commercial market. Thus, this stream of research shapes out the fact that any research ready for the market must possess a certain value of importance not only to the university, but also to the society at large since the knowledge created in such institutions must be transferred to other facets of the economy. As such, universities have tried for over the years to analyse the value created by these inventions to measure the level of the social and economic growth in the economy. Here, studies have focus mostly on the valorisation of technology transfer by universities due to the involvement of organisations and the Government known as the triple helix era.

likewise, the last stream (composes of 22% of the articles) discussed on the internal impact of the university and how they can be analysed or measured. Universities have in recent years engage in the production and marketing of technology with the aim of acquiring some financial benefits to carry on with further research. However, we realised in this stream that most of the articles discussed how universities have put in place procedures to measure their performances which will permit them to decide either to continue in that research field or to engage in new research fields with enormous benefits. Also, it was realised that not all technology that is generated in the university are licenced reasons being that these unlicensed technologies are either for internal use or already exist in the market because of time lag (from the creation to the commercialisation). Nevertheless, the aspect of performance in the academic field could be a measuring rod which permit academia or administrators to successfully transfer long term technology or knowledge with outstanding performance. Thus, all research when put to the market are expected to have a positive impact on both the university (in monetary form) and to the society (economic growth).

7. Conclusion and future implication

Unlike some years back where universities aimed at carrying out basic research, there has been an evolutionary change in the global activities of universities for over the years, which has made universities to gradually divert from only carrying out basic research to a much more commercialise level. This phenomenon can be observed as many universities now compete among each other especially in the domain of advancement in innovation as well as technology transfer. This idea has strengthened the relationship between universities and industries at the level of technology transfer from universities to industries (Jensen and Thursby, 2001).

Consequently, the creation and transfer of knowledge from universities to other organisations is not only capitalised on the advantages of these institutions but to a greater extend geared towards societal benefits which can intend foster regional development. As mentioned by McAdam et al., (2009), spin-out companies as well as licensing arrangements are entities which are highly funded because of the successes recorded in the commercialisation of useful technology generated from basic research. However, such developments are usually accompanied by risk of uncertainty with a greater demand resource funding. Thus, a need to minimise related developmental risk while increasingly allocating resources.

As earlier enlightened, this paper had focus just on a specific part of an enormous literature dealing with technology transfer from Academia, by carry out a systematic review of the literature involving the economic exploitation of the knowledge produced and marketed by universities irrespective of the form it takes. This was done through the systematic analysis of the literature retraced in 34 academic journals and 100 papers specifically dealing with our topic. Differently from previous works carried out on this topic, this review is the first to systematically analyse literature on the financial benefits generated by universities from the numerous knowledge produced in these institutions and the best means through which the income could be generated being it through licensing, the creation of spin-offs, commercialising and transferring these inventions to other institutes or corporations.

On this note, we started by providing a brief introduction and background on outbound open innovation which was first emphasised by Chesbrough in his 2003 book. We also explained that universities are more diverse in their organisations as they have many faculties which are specialised in the production and marketing of Intellectual Properties (IP). Technology and biotechnological industries are referred to as some examples, where they produce and market the greatest technology in the medical history as well as other materials (Macho-Stadler et al. 2007). We also saw that, with the creation of university technology transfer offices, there has been a significant turning point in the commercialisation of university inventions since these offices facilitates the flow and transfer of this knowledge (Siegel et al., 2007; Siegel et al. 2004; Graffet al., 2002; Carree et al., 2014). Though, the key role played by universities in the creation of knowledge, licensing accord, spin-offs and academic start-ups not to mention the process of technology transfer, they are highly considered by this research which has enriched the study in many dimensions (Swamidass, 2012; Giuri et al., 2013).

Nevertheless, this research is not without its limitations which come from the fact that we considered only journal articles and reviews without necessarily taking into consideration other sources such as conference papers, books, and others. In addition, we did not provide any year

limit but had to narrow down our search to the required papers by considering only articles that had most of our keywords to precise our search. The number of papers used in this research might not reflect the exact expectation of the results to be obtained as it is still a growing field of studies with much to be published in the future. Furthermore, most universities during this process, face some challenges such as limited research funding, lack of follow-up of young researchers, competition with other institutions, knowledge spill over and many others which highly differentiate some universities from others. Some authors (Goldfarb & Henrekson, 2003) also explain the fact that the incorrect allocation of incentives to universities could lead to an unsuccessful commercialisation of university technology. These authors took an example of Sweden universities with unsuccessful technology transfer as compared to the U.S. with a contrary result.

It is no doubt that there exist alternative ways through which research from universities can be transferred or commercialised to other institutions or organisations. However, this study has addressed the issue by grouping the research articles in to four streams including knowledge transfer modes and intermediaries, strategic organisation and management, economic and social impacts as well as the internal impact or performances recorded by these institutions. Following this classification, it is evident that though not much is written on the intermediaries and various mode of commercialisation, there still exist a wide range of opportunity to better enhance this stream of research.

This research could thus, be a starting point for most academic institutions especially to the universities, who are more engage in carrying out research as a primordial activity. This is because, this study tries to bring out some issues that are relevant in the invention and commercialisation of university research such as the modes of commercialisation of licencing, organising and management of strategies for licencing, the economic growth and social network in the creation of value as well as the internal impact or performances of these universities. Likewise, literature on university technology exploitation has been carefully categorised and made available with respect to technology commercialisation context, characterised from different viewpoint through the analysis of the various modes.

Furthermore, this research could further be developed by first differentiating state universities from private own universities to analysis the above-mentioned issues separately. The results could demonstrate whether state owned universities do benefit much from licencing their research than private institutions and through which means of commercialisation these benefits come from. In addition, future study can focus on a single continent, country or region and integrate other aspects determining the financial benefits of university licencing such as environmental, social, cultural, political, or religious factors. Likewise, it could be necessary to analyse if the licensing of IP can be influenced by some existing markets during the licensing period. Finally, one of the afore mentioned channels or modes could be concentrated on, and as such well exploited to know exactly the financial benefit that this channel accrues to the university involve. Thus, there is a need to further analyse the measurement of success of technology commercialisation or licencing and to compare these successes with respect to other existing modes.

7 Appendix

Appendix 1

Theoretical perspective	Frequency	%
Resource and Capability Based	7	16%
Knowledge-Based Theory	7	16%
Transaction Cost Theory	5	12%
Technological change and strategic management theories	4	9%
Game Theory	4	9%
Stakeholder Theory	3	7%
Open Innovation theory	1	2%
investment risk perspective	1	2%
Organisational Theory	1	2%
Information Theory	1	2%
Innovation Speed Theory	1	2%
Both deductive and inductive approaches	1	2%
Agency Theory	1	2%
Endogenous Growth theory	1	2%
Grounded Theory	1	2%
Hannan and Carroll's theory	1	2%
New Growth Theory	1	2%
Shannon's Communication Theory	1	2%
Status Characteristics Theory	1	2%
Total	43	100%

Appendix 2

Methods of Analysis	Frequency	%
Regression (Probit, Tobit, Time-lag, Linear, etc.)	20	21%
Multiple Methods	16	17%
Descriptive statistics	11	11%
Multiple Case Study	11	11%
Data Envelopment Analysis (DEA)	5	5%
Game-theoretic model	4	4%
Revenue Maximization Model	3	3%
Semi-Structured Interview	3	3%
Content Analysis	3	3%
Meta Data Analysis	2	2%
Multivariate Probit Model	2	2%
Market analysis	2	2%
Input-Output Model	2	2%
Cohort Analysis	1	1%
cognitive model	1	1%
Company Start-up Model	1	1%
Comparative Cross Case Analysis	1	1%
Business Model	1	1%
Deductive and Inductive Approach	1	1%

Desorptive Capacity model	1	1%
Absorptive Capacity Model	1	1%
Conceptual Model	1	1%
Panel Analyses and Cross-Section Estimates	1	1%
Social Network Analysis	1	1%
Theoretical Analysis	1	1%
Total	**96**	**100%**

Appendix 3

Journals	**Frequency**	**%**
Journal of Technology Transfer	25	21%
Research Policy,	18	15%
Technovation,	8	7%
Science and Public Policy	5	4%
R & D Management	5	4%
Journal of Business Venturing,	4	3%
Research-Technology Management	3	3%
Industry and Innovation,	4	3%
Oxford Review of Economic Policy,	3	3%
International Journal of Technology Management	3	3%
Aei-Brookings Joint Centre for Regulatory Studies	2	2%
Innovation-Management Policy & Practice	2	2%
The Journal of High Technology Management Research,	2	2%
Journal of Innovation Economics & Management	2	2%
Management Science,	2	2%
Journal of Product Innovation Management	2	2%
International Journal of Industrial Organization	2	2%
American Economic Review,	2	1%
African Journal of Business Management	1	1%
California Management Review	1	1%
Canadian Journal Of Administrative Sciences-Revue Canadienne Des Sciences De L'Administration	1	1%
Technology Analysis And Strategic Management	1	1%
European Journal of Innovation Management,	1	1%
Globalization and Health	1	1%
Regional Studies	1	1%
Innovation Policy and The Economy,	1	1%
International Journal of Innovation Management	1	1%
Journal of Business Research,	1	1%
Technology forecasting and Social Changes	1	1%
Journal of Management Studies	1	1%
Journal of The European Economic Association,	1	1%
Journal of The Knowledge Economy	1	1%
Management Decision	1	1%
IEEE Transactions on Engineering Management	1	1%

Organisational Science	1	1%
Strategic Management Journal	1	1%
Long Range Planning	1	1%
Minerva	1	1%
COMUNICAR	1	1%
Total	**118**	**100%**

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Second paper:

The role played by dynamic capabilities in the evolution of the business model of universities' technology transfer offices. An empirical study.

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Abstract

For over the years, universities have created technology transfer office to market their technology. There has been an increase in the challenges that these offices face reason being that there is always limited fund to carry on with the technology transfer activities. Thus, these TTOs are forced to advance new means by developing and implementing new business models that can generate them more income. However, our claim here is to know to what level dynamic capabilities influences the successful implementation of a business model. This research was carried out by conducting 5 case studies based on qualitative methodology with interviews of TTO representatives. From our analysis, a greater part of the TTO were involve in sensing and seizing of opportunities while only few were reformed. Also, the results show that, most of these TTOs were highly engaged in activities that characterises the dynamic capabilities which have intend influenced the implementation of new business models or strategies by these offices in order to acquire more financial resources and withstand competition with adversaries.

Keywords: Business model, dynamic capability, technology transfer office, university.

1. Introduction

Knowledge exploitation activity in the university has for over the years been influence by the presence of several intermediaries amongst which Technology Transfer Offices (TTO) is the most outstanding as it permits most universities to better organise and manage their knowledge. This structure is made available by Universities with the aim of facilitating the process of technology or knowledge transfer from university to the market (Thursby et al. 2002; Siegel et al., 2007; Hall et al., 2014; Mesny et al. 2016; Slavtchev & Göktepe-Hultén, 2016). It also facilitates relationship of these institutions with other organisations (mostly companies) to increase the impact of knowledge transfer (Bauer et al., (2018).

The establishment of TTOs in universities have led to some managerial problems as well as competition with other universities that carry out similar activities. Some of these challenges, as explained by Lubik & Garnsey, (2016) include the followings: limited commercial experience, conflict of objectives in the advancement of science, wealth creation as well as the need for substantial resources mostly financial. This have exposed the university to a competing logic that do not only challenges the public nature of science but creates conflicts among faculty (Baglieri et al., 2018). In addressing the above challenges, technology transfer offices must intensify their collaboration with researchers by developing new strategies or business models.

These new developments could successfully protect and commercialise the intellectual property and the inventions across the boundaries of organisation (Pries & Guild, 2011). Though there is still an ongoing debate on the definition of what a business model is (Wirtz et al.,2016), some authors have harmonised different definitions to come up with a more accurate definition. For instance, according to Zott and Amit's (2010, p. 216) is a 'system of interdependent activities that transcend the focal firm and spans its boundaries'. Thus, the concept of business model generally refers to the articulation between different sectors of the activities of a firm which is designed to generate value to customers as well as the organisations or institution which in this context is the TTO.

In considering the nature of an innovative business model, Zott et al. (2011) refer to it as an innovative element of analysis which is grounded on its standard importance for competitive advantage with recent study dominated by the cost/revenue architecture. Nevertheless, further research is needed on how designing and architecting business model can enhance performance in numerous sectors, including universities and research centres (Schneider et al., 2012). This, according to some authors does not fully acts as a catalyst of their growth process nor increase their level of profit (Balboni & Bortoluzzi, 2015).

The above concern is also shared by some authors as they explain that displaying high number of active licences does not necessary means that the university obtain high income from sales. This idea according to Baglieri et al., (2018) is constant when compared to European TTOs funding which differs not in terms of the licences, but the revenue obtained from it. Thus, there is a need to better organise the various business models with respect to the tools and processes. In addition, Universities on this note are to develop a wider range of relationships with various stakeholders as well as increase their capacities which in this case is

the implementation of dynamic capabilities to enhance regional innovation systems (Miller et al., 2014; Baglieri et al., 2018).

Our claim here is that dynamic capabilities can greatly contribute to the development of a good business model. Also, it can explain the reason why some TTOs are more agile in the adaptation of their business model to the changing conditions of the environment. The argument is supported by Teece, (2010; 2012), when the author refers to Dynamic Capability (DC) as a significant level of competence that determine the capability of firms to either integrate as well as reconfigure both internal and external resources or competences to possibly address the rapid changes in the business environment (Teece et al., 2016). Since technology transfer has become a global phenomenon which is more demanding especially at the level of universities, many institutions have involved in the activities which has become more competitive in the technological market (Baglieri et al., 2018). This has gradually prompted universities to create specific centres such as the TTOs which can better manage the intellectual properties of the researchers. As such, new models are to be put in place to better organise this sector due to competition in the technological market.

Furthermore, recent studies have demonstrated that dynamic capabilities can determine both the speed and the degree to which the resources of an organisation can be aligned and readjusted to match not only the requirements, but the opportunities of the business environment which generates sustainable positive returns (Teece, 2018). Consequently, this alignment of resources (mainly financial) which comes from both within and outside the universities could permit TTOs to self-assess when or how to adapt a business model. This can permit them to either form alliances with other universities/organisations or not. Therefore, this research aims at deepening the role of dynamic capabilities of TTOs in supporting the process of business model evolution. This shall be discussed with respect to the framework provided by Teece which according to our context greatly determines the implementation of a good model. As such, the main question that is addressed in this research is ‘what role does dynamic capabilities plays in the implementation of a good business model in the TTO?’.

Thus, this paper contributes to the existing literature in many ways, firstly, this study aims at studying the role play by dynamics capabilities in the evolution of business model in the technology transfer office (TTO) which could be very beneficial to the university and other organisations. Also, this research analyses the relationship existing between business model and the dynamic capabilities which is essential for future research in analysing these two concepts. Furthermore, the research has also come up with various definitions as to what business model is about which makes it easier for future researchers to have easy access in analysing the different definitions depending on the field of studies.

This paper is further organised as follows. Section 2 presents a theoretical background on university technology transfer offices, Business Model, and its Evolution as well as the importance of Dynamic Capabilities in adopting a successful business model. Also, the framework of Business models in the dynamic capabilities of TTO shall be discussed. Section 3 explains the methodology and the method used in this research which is a case study conducted in TTOs through interviews about the evolution of their business models. In section 4, the results shall be interpreted, analysed, and discussed where possible solutions or recommendations shall be examined which could be very significant not only to researchers,

but as well to managers and policy makers. In section 5, the conclusion shall be based on suggestions, limitations, and opportunities for future research.

2. Background

2.0 The changing role of Technology Transfer Offices

Technology transfer has increasingly played a significant role in fostering the growth of the economy (Siegel et al., 2003). This increase has been experienced in the past with the enactment of some legal acts which permitted most Universities, especially in the US, Europe, and some parts of Asia to own and market their intellectual property. For instance, the enactment of the Bayh-Dole law in the 1980 in the U.S., the Science and Technology Basic Law (STBL) in Asian countries, including Taiwan, Japan and Korea (Chang et al., 2008), alongside similar legislations adopted in the European context (Penin, 2010 and Casper, 2013), have improved Universities' efforts in marketing their novel ideas. This has in a greater aspect supported especially the commercialisation of federally funded research (Friedman and Silberman, 2003). This is done by supporting the activities of licensing as well as different methods of intellectual property (IP) emanating from university study (Siegel et al., 2004; Macho-Standler et al., 2006; Baglieri, 2009).

Technology Transfer Office (TTO) has been singled out by academic institutions as the most prominent form of intermediary which is mostly used by Universities with the aim of facilitating technology transfer processes to the technology market (Thursby et al. 2002; Siegel et al., 2007; Mesny et al. 2016; Slavtchev & Göktepe-Hultén, 2016). These TTOs have greatly assisted in the commercialisation of ample knowledge generated from the university which have evolved for over the years (Hall et al., 2014; Fitzgerald and Cunningham, 2015). This has as well influence both the efficiency as well as the efficacy of technology transfer within universities through some factors. For instance, the inflexibility of bureaucracy, cultural clashes, poor systems of reward, the ineffectiveness in the management of the TTO (Siegel et al., 1999; Bozeman, 2000; Leitch, & Harrison, 2005; Muscio, 2010). Consequently, the presentation of technology transfer office is regarded both as experimental and strategic issues vis-à-vis the actions and universities drives (Siegel et al., 2007).

Despite the numerous efforts put in place by some universities in order to better organise the technology transfer offices in their respective institutions, a lot is still to be done in its organisations as well as its managerial aspect (Anderson et al. 2007; De Falco, 2015). This aspect of a better management of the TTOs has been address by Chang et al., (2015) and Lach and Schankerman, (2003), where the authors mention that many researchers are now willing to disclose their research to these offices to be commercialised. This, according to Jensen et al., (2003) has been an issue in the last two decades. Hellmann (2005) on one hand replicates the benefit of TTO over distinct scientists regarding low costs for the search of possible buyers, with reasons being that they are more specialised and has a lesser time-cost opportunity. This author discovered that most experts delegate their research to TTOs only if the patent is protected. This aspect is explained by Bercovitz et al., (2001) where the authors suggested that it could be because of the size of the TTO and the limited number of papers that has clearly explains the theory of the basis on which TTO is founded.

Thursby et al. (2001) further explain that size constitutes a significant element when regarding the routine of TTOs in the universities which is commonly measured by the number of staffs in this sector. This performance according to the authors has a direct link with the number of disclosures obtained from researchers with the U.S. being a clear example. Consequently, it is unavoidable to separate the multifaceted networks by which the size impacts the performance of TTO, principally any effects of large-scale economies from the influences of character. Meanwhile, Chukumba and Jensen (2005) discover that, beside the size and TTO's stage of development, the value of engineers in the faculty greatly enhanced the activities of technology transfer and licensing in the university. Though Weckowska, (2015) partially shares the same view, this author points out that TTO could constitute a barrier on efficient and actual technology transfer due to bureaucracy (Siegel et al., 2003) or bottlenecks (Litan et al., 2008).

In a similar manner, a theoretical model is proposed by Hoppe and Ozdenoren (2005) by exploring the circumstances where innovation mediators, namely TTOs, is developed to minimise the issue of uncertainty. As stipulated in this model, firms find it difficult to estimate with certainty the value of their technology. Nevertheless, intermediaries such as the TTO can obtain new experts who could identify new inventions, come out with profitable investments in addition to assessing the level of efficiency of potential licensees (Hoppe and Ozdenoren, 2005). The authors demonstrate that the fixed setup costs of TTOs could be recovered if the size of the invention is big enough to exploit the new skills employed. Despite the effort put in place by creating the TTO to resolve the problem of uncertainty, there is still some doubts on the end results since coordination might not be efficient.

Thus, the continues activities of technology transfer in university according to (De Beer et al., 2017) is centred on one hand on the continues pressure mounted on these universities to generate money from the transfer of technology. This has forced them to cooperate with other universities, industries, and the government and as such generating more benefits to several participants (Algieri et al. 2013; Siegel and Wright 2015a). On the other hand, much pressure also results from competition due to the standardisation of the transfer of technology grounded mainly in the metrics of Association of University Technology Managers (AUTM) worldwide. The bias here as explained by De Beer et al., (2017) is that the AUTM might hardly represent the entire productivities of technology transfer reason being that emphasis is laid on the monetary part. This has influenced the making of decision by university administrators rather than the business model to be implemented. Thus, to better understand the notion of business model, we shall first examine its evolution through some definitions by different authors.

2.1 Business Model (BM) and Business Model Evolution (BME)

For over three decades, universities have implemented new ways of enhancing their technology transfer offices, and one of the most important way is through the adaptation of new business models. In this study, we shall discuss on how the business model especially in TTOs have evolve over time. In a general manner, a business model defines a style through which value is created and distributed by a firm to its customers as well as the mechanisms put in place to capture a share of that value. It is a coordinated set of elements surrounding the flows of costs, revenues, and profits. With a clear intention of making profit, the designation and implementation of business model has greatly enhanced the success recorded by business

just like in the case of a variety of technologies as well as process of concrete resources and equipment.

The business model provides a path through which technological innovation and knowhow combined with the use of assets (tangible and intangible) are transformed into a stream of profits (Teece, 2006). As such, elements of a business model must be internally aligned and coherent (Ritter, 2014). For instance, the business model must be aligned with the internal structure and overall management model of the company for a better implementation (Birkinshaw and Ansari, 2015). To better understand what a business model is and what it is not, some definitions shall be presented with different views from authors of diverse background.

2.2 Business model evolution and the University context

Business model has for over two decades become very important to both university researchers as well as organisations which has let to successful implementation of better strategies (Massa et al., 2017). Notwithstanding the numerous meanings allocated to this term, business model concept has witness greater significance in analysing events geared at solving issues concerning creating and capturing worth (Baden-Fuller and Haefliger, 2013). With the growing awareness of the importance of business model, some universities have still not made use of this advantage in its adoption (Mets, 2010; Dottore et al., 2010; Miller et al., 2014; Cesaroni and Piccaluga, 2015). Nevertheless, business model has increasingly become a very useful conception, especially in some field of studies such as strategy (Teece, 2010; Casadesus-Masanell & Zhu, 2013), technology and innovation management (TIM) (Massa & Tucci, 2014) as well as in environmental sustainability and social entrepreneurship (Seelos & Mair, 2007; Schaltegger, Ludeke-Freund, & Hansen, 2012).

Furthermore, as explained by Casadesus-Masanell & Zhu, (2013) and Massa & Tucci, (2014), the aspect of innovation has gradually shifted from the conventional which is this case were complements such as products, process as well as organisational innovation. These according to the authors have widens the borders of events and theories related to innovation. A clear example is provided by Cennamo & Santalo, (2013) where the authors explain that businesses which are operated on a platform as well as those related to business models often do not automatically focus on the traditional aspect (creating tangible product and selling through a traditional sales channel). Choudary, (2015) on the other hand explains that the creation of value in recent years is mostly facilitate through the control of the economics as well as the social connections, which is regarded to be more interesting by practitioners.

Also, the evolution of internet technology as well as globalisation has blurred the differences between industries and the reduction of barrier to entry which has led to a more rigorous competition (Gambardella & McGahan, 2010; Hacklin, Marxt, & Fahrni, 2009). As a result, universities (through their TTOs) and companies are forced to reconsider how their goals (for instance value creation, expansion and social impact) can be achieved by seizing new and existing opportunities in order to design new business models. (Kim & Min, 2015; Massa & Tucci, 2014; Osiyevskyy & Dewald, 2015).

Dohrmann, Raith, & Siebold, (2015) also suggested that the concept of business models has greatly been utilised in recent years by both managers as well as researchers (with the help

of the TTOs) in the creation of environmental, social as well as economic values. As explained by Lüdeke-Freund et al., (2016), there are numerous opportunities now that are involved in designing new business models capable of readjusting both organisations as well as institutions for profit generation and economic growth. This arguments in confirm by Zott et al. (2011) as the authors explain that this has drawn the attention of many scholars. For instance, these authors after examining 74 academy of Management Annals January evolution of the use of the term "business model" came to the conclusion that, in the first half of the mid-1990s, there was an explosion of articles about business models, including scientific works published in peer-reviewed journals. Figure 1 shows a cross-sectional analysis of the number of articles published including the term "business model" which shows the continuity of the movement through 2015 up till date.

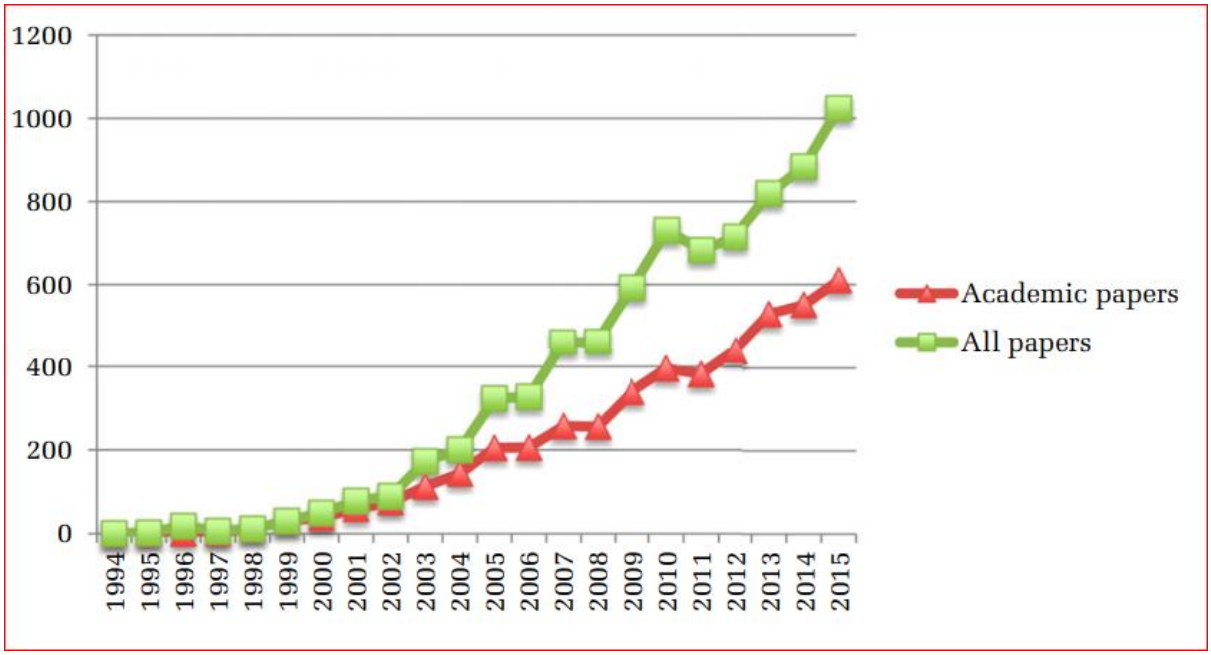

Fig. 1 Growth in Business Model Research (Number of Articles Published Per Year); (Massa et al. 2017)

This research shall proceed (as stipulated in Table 1) to shows a summary of the evolution of various definitions of business model from 1996 to 2018 which is adapted from the works of (Zott and Amit, 2010). Also, in a broader way, the evolution of the business model refers to a substantial variation in the cost and revenue structure by using new resources to develop new source of revenues. Additionally, by reengineering the process of an organisation as well as extending the activities of value chain which are either triggered deliberately or environmentally (Demil and Lecocq, 2010). As emphasised by these authors, the increase in size and volume does not necessarily mean a change in the business model which in this case is structural and as such considered as the first 'symptom' of the evolution of business model.

Table 1. Definitions of business model

Author(s) and Year	Definition (s)	Focus
Slywotsky (1996)	Refers to business model as ‘‘the totality of how a company selects its customers, defines and differentiates its offerings, defines the tasks it will perform itself and those it will outsource, configures its resources, goes to market, creates utility for customers and captures profits.’’	This definition focusses on competitive advantage and sustainability with elements including the creation of value, networks and alliances, vision, diversity as well as identifying stakeholders.
Timmers, (1998)	Defined the business model as “an architecture of the product, service and information flows, including a description of the various business actors and their roles; a description of the potential benefits for the various business actors; a description of the sources of revenues” (p. 2).	This definition focus on the market of electronics which without a strategy contributes nothing to the mission.
Mayo and Brown (1999)	Identify business model as ‘‘the design of key interdependent systems that create and sustain a competitive business.’’	This definition is considered at the strategic level and focuses globally on the positioning, growth opportunities and interactions across the organisational boundaries of the firm’s market.
Stewart and Zhao (2000)	Approach the model as ‘‘a statement of how a firm will make money and sustain its profit stream over time.’’ (p. 290).	The definition focusses on Internet marketing, business models and public policy concepts
Amit & Zott, (2001); Zott & Amit, (2010)	The business model portrays “the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities” (2001: 511). Due to the relationship business has with activities, this definition further evolved by conceptualising the business model of a firm as “a system of interdependent activities that transcends the focal firm and spans its boundaries” (2010: 216).	The focus of these definitions is on the structure and governance

Chesbrough & Rosenbloom, (2002)	Defined business model as "the heuristic logic that connects technical potential with the realization of economic value" (p. 529).	This definition focuses on the consistency in finding the architecture of the revenues.
Magretta, (2002)	Business models are "stories that explain how enterprises work. A good business model answers Peter Drucker's age-old questions: Who is the customer? And what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?" (p. 4).	This definition focuses on the logic by which the organisation earns money
Morris et al., (2005)	A business model is a "concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (p. 727). With 6 essential components: Value proposition, customer, internal processes/competencies, external positioning, economic model, and personal/investor factors.	This definition from the strategic level focus on the internal processes and design of the infrastructures enabling the creation of value by firms.
Johnson et al., (2008)	Business models "consist of four interlocking elements, that, taken together, create and deliver value" (p. 52). These are: customer value proposition, profit formula, key resources, and key processes.	This definition focuses on the vision-level of a company
Casadesus Masanell & Ricart, (2010)	Business model refers to "the logic of the firm, the way it operates and how it creates value for its stakeholders" (p.195).	The definition focus on distinguishing and relating the concepts of business model, strategy, and tactics.
(Balboni & Bortoluzzi, (2015).	A business model refers to ''a set of decisions that relate to a firm's market strategy, organisational structure and the activities it performs both inside and within the business environment through a network of transactions'' (p. 123).	This definition focus on the literature on business strategy, organisation design, transaction theory as well as business networks

Massa et al. (2017)	In a more general manner, a business model is "a description of an organization and how that organization functions in achieving its goals" (p. 73).	This definition focus generally on profitability, growth, social impact etc. and requires some level of consensus on effective definitions among academics
Teece, (2018)	A business model "describes the design or architecture of the value creation, delivery, and capture mechanisms [a firm] employs. The essence of a business model is in defining how the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (p. 41).	It focusses on the architecture of prices, costs as well as revenues

Table 1. a summary of some definition of business model adapted from (Zott and Amit, 2010).

As highlighted by Pries & Guild, (2011), adopting a "proper" business model is challenging, since empirical evidence on the topic (and that could provide TTO managers with practical suggestions and best practices to imitate) is scarce. Reason why Miller et al. (2014) explains that recent literature and policy has necessitated university TTOs to re-consider their business models which has been neglected in the past due to its complexity and practices as well as limited empirical study in its implementation at the university level. The business models of University TTOs are said to be illustrated by engaging widely with the society (Cesaroni and Piccaluga, 2015). These are progressively replacing those models which are more centred either on the creation of academic spinoffs or licensing agreements (Dottore et al., 2010; Mets, 2010). However, of recent little is expressed on the different types of business models that the university TTO may adopt in carrying out technology transfer activities (Baglieri, Baldi, and Tucci 2018).

As highlighted by Massa et al., (2017), the term "business model" has been very important among scholars as well as practitioners. Despite several definitions, this concept has emerged as a unit of analysis including actions geared towards resolving the challenge of creating and capturing value (Baden-Fuller and Haefliger, 2013). This concept has surprisingly been implemented beyond the management literature. For instance, to understand the Labour political Party in the UK as well as discussing the models used by the economy of the US (Faucher-King,2008; Cappelli, 2009). Notwithstanding this growing interest in the use of business model in more than a few field of studies, most university TTO has still not make good use of the concept (Miller et al., 2014; Cesaroni and Piccaluga, 2015).

In over-all, there is still an ongoing debate on the definition of business model which is considered by several authors as being too fragmented (Da Silva and Trkman, 2014; Wirtz et al.,2016). Despite this fragmentation, few researchers have provided some definitions as can be seen in table 1. In addition, business model has gained a lot of grounds in the managerial

literature especially in the late 90s where advanced technology such as the internet and e-commerce were introduced (Ghaziani & Ventresca, 2005).

From a global point of view, the definition of a Business model is referred to by several authors as a dynamic concept where each definition suits a characteristic. For instance, Amit & Zott, (2001) refers to it as a structural template; Morris, Schindehutte & Allen, (2005) as a representation, Timmers, (1998) as an architecture and Stewart & Zhao, (2000) as a statement. Moreover, the definition according to Morris et al. (2010) (which is defined from the strategic level and emphasis on the internal processes and design of the infrastructures enabling the creation of value by firms) is considered as an integrated definition. This is because the authors carefully examining the definition of three different authors and combine them to come up with one. That is, the definitions by Slywotsky, (1996) which focusses on competitive advantage and sustainability; Mayo and Brown (1999) who defined at the strategic level across the organisational boundaries of the firm's market and Stewart and Zhao (2000) that defined at the operational level and focusses on Internet marketing, business models and public policy. As such, the definition at the strategic level are considered by Morris as the most prominent.

Significantly, the definition provided by Zott and Amit (2010) is referred to as a structural template which spells out the architecture of prices, costs as well as revenues, permitting the profitability of the business. Consequently, the concept of a business model explains the strategy of creating, capturing and delivering value, which the organisation or firm implements being it on business strategies, organisation design, transaction theory as well as business networks (Balboni & Bortoluzzi, (2015). Thus, business model involves defining how value paid by customers is delivered and converted to income (Teece, 2018).

However, some of these values when defined by the available business model turn to suit just the case involve and any modification might not yield the required or expected result as such disrupt the cumulative progress of the model. For instance, the literature on business model is developed in silos with specific interest areas or research such as strategic issues, E-business as well as innovation and technology management (Zott and Amit, 2010). This explains why Knowledge Technology Transfer Office (KTTO) managers consider the designation of a business model as a significant decision because once established, it becomes difficult to change the model. This is because of the forces of inertia and resistance to change, as the services are already put in place and resources fully committed (Zott and Amit, 2010).

This notion of considering a new business model as being a significant decision to be well-organised has evolve over time as a lot of studies now regard business models as the basis of capturing, creating, and delivering organisational values. These values as explained by (Massa and Tucci, 2013) could either be social, economic, or otherwise which is liked with diverse associates. In this case, the value created is refer to as the stakeholder's engagements whereas the capturing of value is being considered as those that are distributed across monetary values (McGrath and MacMillan, 2000; Teece, 2010). A significant portion articulates how stakeholders uses the business model to value what the organisation has to offer them with more focus on the transfer of technology in university (Afuah and Tucci, 2003).

To better valorise the idea of a good business model, four fundamentals are acknowledged by Baden-Fuller and Mangematin (2013) including identifying, engaging, monetising as well as associating customers in a value chain. These elements are transferred in the university settings (mainly the actions of technology transfer) which are of significant

(brings financial benefits) to both the universities and the internal and external stakeholders involve (Miller et al., 2014). These authors identify the implementation of University business model in some universities across Europe which has help to influence regional innovation as well a smooth transition of the business model within universities.

Miller et al., (2014) further highlight that, universities have witnessed some significant changes in the past. This is resulting from the evolution of their business models which have gradually shifted from the traditional or laissez-fair in the era where most universities where still in control by the state. As such, knowledge was mostly transferred into society through teaching, research as well as dissemination which contributed enormously to technology transfer through the provision of well trained and qualified workforce to industries (Carayannis et al., 1998; Gibb, 2010).

Gibb further highlights that in the transition period, ad hoc committee were later formed for better interaction which later rendered each stakeholder autonomous as depicted in fig. 1. The fact that universities became independent from government funding was thanks to the introduction of the Bayh–Dole Act and other similar laws in Europe and Asia (Sharma et al., 2006). This link has thus been re-established through the creation of some centres in the universities (such as Technology transfer offices, industry liaison, incubators as well as Science Parks) purposely to transfer technology to industries. All this is thanks to the evolution of University Business model which as well valorised this sector.

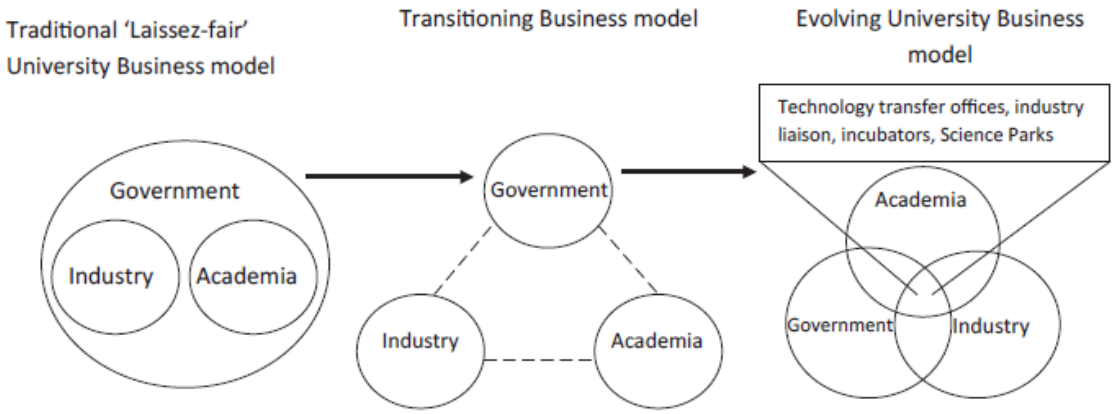

Fig 1. An overview of the evolution of business model in the university. Adapted from Miller et al., (2014, p. 4).

Generally, business models in the university are categorised broadly with the intervention of society at large (Cesaroni and Piccaluga, 2015) which progressively substitute other specific licence engagements as well as spin-offs in the academic field (Mets, 2010; Dottore et al., 2010). Thus, understanding both business models as well as identifying those which are linked to technology transfer might benefit the impact exerted by universities to society. This idea as recently expressed by Baglieria et al., (2018) also makes available leadership that can better assess the procedures of the agendas to be put in place. Correspondingly, the concept of Dynamic capabilities as recently highlighted by Teece, (2018) to be one that is deeply entangled with business model innovation and implementation must be addressed. This is because they partly exist in the collective learning and culture of the organisation as well as the managerial skills of the management team (Leih et al., 2015).

2.3 Dynamic capabilities concept and its relationship with business model

Dynamic capabilities can be easily understood in the framework of a global collection of capabilities in an organisation, which is usually regarded as being operational on two levels (Winter, 2003). As explained by this author, the base level includes operational as well as normal capabilities involving activities such as administration, routine and basic governance permitting organisations to follow specific production programs, or well-defined set of activities which are relatively efficient. Teece, (2007) further highlights that this layer of dynamic capabilities could further be divided into "micro foundations" as well as ''higher-order capabilities''. This author refers to the former as adjustment and recombination of a firm's existing ordinary capabilities as well as the development of new ones. Likewise, the latter involve developing, expanding as well as assigning these capabilities to various divisions for a better implementation.

The idea of dynamic capability involves the creation of market changes from processing the available resources which are being used by the firm for instance the processes of reconfiguration, integration, benefits as well as the release of resources. Teece (2018) in recent years refers to the concept of Dynamic capabilities as being the routines which are well organised and strategic in nature that permit firms to configure innovative means as marketplaces develop, crash, fragmented, develop, and perish. However, the scenario of competition as earlier explained by Teece et al., (1997) is progressively dominating the dynamic capability where managers of firms are involved in integrating, building as well as reconfiguring competences. These competences according to the author could be from within or outside the organisations which address the sudden environmental change that has resulted to a sustainable and advantageous competition.

The concept of dynamic capabilities as earlier stated in this research can be detailly discussed by considering three items (see figure 3). These are, to identify opportunities, take hold of them and later convert or alter them to suit the strategies that are put in place for a better implementation of a new or existing business model. This can be effectively implemented by upgrading the regular capabilities (already existing capabilities) in an institution (in this case the TTO) as well as those of partners (collaborators from other universities or companies) towards higher remuneration activities. This is done by arranging the available resources (mostly financial) of the Technology transfer office and even make some changes in the technological market or the business environment in general. Teece further explain that the speed as well as the cost associated in an organisation is determined by the strength of the dynamic capability which shapes both its resources and business model to satisfy the needs of customers (in this case, we refer to the companies). Thus, there is a need for a continuous sensing, seizing as well as transforming the cultural and organisational aspects which permits the institution to be more proactive in addressing recent opportunities and threats that might arise within that period.

This model depicts that not all institutions are strong or tough enough in all the three capabilities that are mention in this framework considering their multifaceted nature. For instance, an organisation might be very good in the development new business models but faces some issue in its implementation. As such, this organisation looks vulnerable in sensing, seizing, and altering the available opportunities as compare to its rival (other related organisations). In the same line, some institutions might be stronger in sensing opportunities and at the same time have some difficulties in identifying better business models relative to the competitors. As such, the profitably building and renewing of ordinary (normal) capabilities

and the available resources (financial and human) by an institution is highly dependent on how strong its dynamic capabilities are. This will permit them to be adapted according to how they can either be innovated or influence the technology market. Some researchers (Eisenhardt and Martin, 2000) have for over the years constrained the idea earlier proposed by Teece that dynamic capabilities are partly reinforced by the routines and process of an organisation which could be disrupted through the intervention of non-routine management (Teece, 2012).

With this framework, it can be realised that managerial competences which is also considered to be the main component in the dynamic capabilities of a technology transfer office plays a greater role in seizing new opportunities. This according to Teece (2007) involves the development and management of a good business model. Recent studies have shown that there has been a gradual shift of these managerial competences which have for over the years metamorphosised in to what Helfat and Martin, (2015) refers to as the dynamic managerial capabilities. These authors considered the designation and the implementation of new business model as a very significant feature of an organisation especially in this era of an increase in technology development.

Teece, (2014a) concluded that since the dynamic capabilities are developed from the enhancement of the historical routine or culture of an organisation as well as on the individual characteristics of the entrepreneurial managers, it is practically impossible to be duplicated by the adversary. Thus, permitting the institution (which in this case is the TTO) to better manage its technology transfer activities successfully without fear. An early stage business model is part of the dynamic capabilities that are unlikely to be fully routinised as it mostly depends on individual perceptions. In this case, Teece, (2012) also explained the importance of organisations in scheduling regular meetings in the evaluation of the outcome of new business models though this process is insufficient in determining the best choice among numerous options that exist.

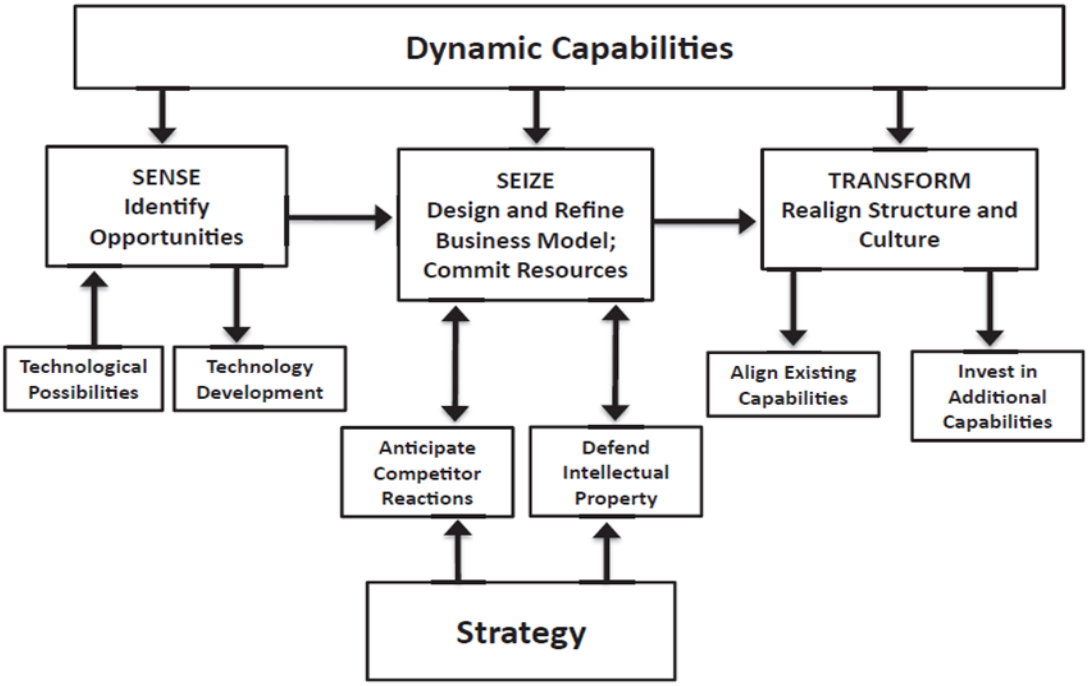

Fig. 3. Summary of dynamic capabilities, strategy, and business models diagram. Adapted from Teece, (2018).

As earlier mentioned in this paper, dynamic capability will permit TTOs to process their available resources accordingly to meet up with the requirements of technology markets by considering the sensing, seizing as well as the reconfiguration. As explained in this framework, TTOs in the first step identify new opportunities such as involving in the innovation of new technologies or knowledge that can be transformed into sellable assets mainly in the technology markets. To succeed in administering these newly identified opportunities which are seized by the TTOs, care is to be taken in considering the definition as well as improving on the type of business model to be adapted. This will permit them to better allocate the limited resources (mostly financial) available to carry on with an effective and profitable commercialisation of the intellectual property.

For a better implementation of the business model, technology transfer offices are to anticipate the reactions of their opponents who operate in other universities. This involve defending the intellectual property, which is to be marketed, by issuing patents that permit these rivals not to copy and as well make sure that their opponent has not yet introduce the same technology in the market.

Thus, a specific strategy must be put in place to ensure the smooth transfer of technology to other sectors of the economy. The framework that we used in this study is borrowed from the works of Teece (2018) where the author defined what is business model and what it is not by carefully differentiating it from dynamic capabilities, strategy, and investment decisions. Teece explained the concept of dynamic capability by looking at the sensing, seizing as well as its transformation with focus on firms. However, our emphasis here shall be on university technology transfer offices (TTOs) in which case we shall elucidate on the above-mentioned items.

As earlier mentioned by Teece (2012), these models are shaped by the unique history, value and routines of the environment which allow the TTO to adjust its activities considering the shifting nature of this business environment. In view of the uniqueness and importance, robust dynamic capabilities could be the basis of sustaining the advantages of competition in the TTO. As recently confirmed by Teece (2018), the better capabilities are rooted in organisations or institutions, the less they are occupied just at the higher position of management. This explains why most TTOs are composed of fewer staffs with the aim of close collaboration and communication with top managers.

The definition recently advanced by Teece is constant with that earlier proposed by Helfat et al. (2007) where these authors refer to dynamic capability as being the deliberate extension, creation as well as modification of the resource base of an organisation. The capabilities in this sense are said to be Dynamic as they include several aspects such as the entrepreneurial activities, processes, and leadership skills. Thus, there is great need for the recognition of the changing/innovating existing business models as well as the required assets geared for pursuing new value creation.

For a better understanding of the concept of dynamic capabilities, it can also be observed from the point of an “entrepreneurial manager” which is considered as the core studies of this concept (Adner and Helfat, 2003: 1012). These authors thus referred to “dynamic managerial capabilities” as capabilities “with which managers build, integrate and reconfigure organisational resources and competences”. This definition according to the authors is considered as a direct analogy to the dynamic capabilities of an organisation which is further

refers to as capabilities enabling organisation ‘‘to integrate, build, and reconfigure competences.’’ (Teece, Pisano, and Shuen, 1997: 516).

In the same perspective, the idea of entrepreneurship management is highly influenced by the concept of dynamic capabilities of a firm as the concept cannot easily be replicated. This according to Teece, (2016 and 2018) are built on the idiosyncratic characteristics of entrepreneurial managers and the history-honed routines and culture of the organisation.

To define and measure “entrepreneurial management”, Teece (2016; EER) refers to the concept and to the scale originally developed by Gupta et al., (2004). We also refer to the study by Gupta et al., (2004: 247) especially to the scenario enactment skills of the “entrepreneurial manager”. Scenario enactment consists in “envisaging and creating a scenario of possible opportunities that can be seized to revolutionise the current transaction set, given resource constraints”. The link with the work by Teece and the concept of dynamic capabilities is clear, since envisaging corresponds to sensing opportunities, seizing such opportunities correspond to seize while revolutionise the current transaction set corresponds to reconfigure or transformation. This framework proposed by Teece shall be discussed which links the business model to the dynamic capabilities.

As Amit, & Zott, (2014) further highlights, the rapidly changing economic landscape, combined with transformational advances in information and communication technologies, presents many challenges to managers of large and small enterprises alike. They need to adopt a universal approach to renew and innovate the capabilities of their organisations, mix product and service, product-market strategies, activity systems, among others. For these challenges to be addressed, some scholars over the past two decades have come up with two viewpoints which are strategically derived from management literature: the first as articulated by Amit and Zott, (2001) is what they termed dynamic capabilities paradigm. On the other hand, the second opinion is known as the business model perspective which was proposed by Teece et al., (1997). However, with some exceptions coming from Teece, (2007), these perspectives have been independently studied which today is a call for concern.

Teece (2007) further points out that dynamic capability describes how an organisation extends its strengths "through the advancement of new business models" and how "the business model is being synchronised together with the business environment." The above relation results from the explanation of dynamic capability earlier postulated by Teece et al., (1997) as being a higher order capacity that can assist in building a firm, integrating it as well as reconfiguring both its internal and external resources. This as explained by the authors will go a long way to cater as well as shapes the rapid changes in the business environment.

Teece (2007: 1330) further related these two concepts in the following manner: "The capacity an enterprise has to create, adjust, enhance, and, if necessary, replace business models is foundational to dynamic capabilities." In line with the definition, Helfat et al., (2007: 4) also referred to the concept of dynamic capacity as being the “capacity of an organisation to purposefully create, extend, or modify its resource base”.

Nevertheless, as suggested by Amit and Zott (2014), the business model design process is indeed a dynamic capability. As expressed by these authors, scholars have in recent years divert their attention to the dynamics of creating business model as well as adapting and changing, partly by drawing on the design perspective. These authors in bringing out the link

between dynamic capabilities and business model uses the five-stage-model of design to highlight the links between business model design as a process and the dynamic capabilities paradigm of strategic management (fig. 2). In subsequent explanations, we shall refer to these steps by briefly explaining and linking them to the context of dynamic capabilities (Teece, 2007).

To fully develop this model, the authors came up with some few questions that were worth addressing some of which are what are dynamic capabilities all about? How can managers and firms develop and connect them in order not only to achieve but to sustain competitive advantage? To address these questions, the authors suggested that the concept of micro-foundation of dynamic capabilities should be well be analysed by scholars which shall be discussed subsequently in this research.

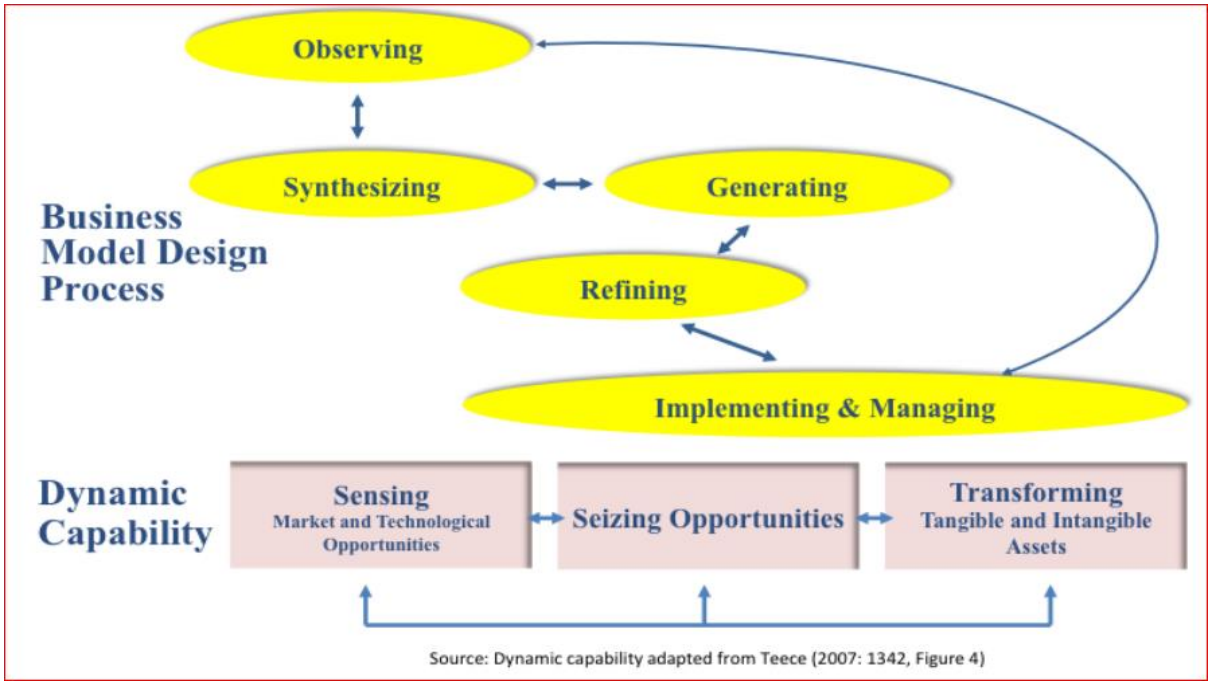

Fig. 3. The relationship between business model and dynamic capabilities

As depicted in figure 3, one can conclude that the idea of observing and synthesising in designing a business model corresponds to the sensing (market and technological opportunities) in the dynamic capability. In a similar manner, we also have the idea of generating and refining information in the designation of a good business model. This idea goes along with the proposed by Teece, (2007) as a dynamic capability which is seizing opportunities. Lastly, the implementing and managing of the business model also consist of transforming as well as reconfiguring both the tangible and the intangible assets as proposed by Teece which shall be further be developed in subsequent paragraphs.

I order to give a clear picture on the link between the evolution of the business model and the concept of dynamic capabilities, we shall borrow from the idea of Amit and Zott, (2014) where these authors tried to analyse and bring the two phenomenon together. The authors established this link by designing five different stages (which they considered to be the main drivers) of a business model with the first one being the observation phase. In this stage, the authors point out that a deeper explanation of designing a new business model could better

handle especially the issues that are usually faced by customers in acquiring or consuming the goods and services involved (Boland and Collopy, 2004).

With the above explanation, the idea of sensing new opportunities as earlier explained by Teece actually increases which according to Brown, (2009: 41) is likely generated "by observing the odd practices of an amateur carpenter or the incongruous detail in a mechanic's shop than by hiring expert consultants or asking 'statistically average' people to respond to a survey or fill out a questionnaire". Thus, this first stage (observing stage) of designing the development of the business model is associated to the first dynamic capability model which is sensing. This constructs as explained by Teece (2016) involved the exploration of technological opportunities, penetrating the markets as well as preoccupying with the demands of the consumers.

The next stage of designing a new business model as proposes by Amit and Zott is that of synthesizing where the designer has a greater advantage in benefiting completely as well as understand the many issues and questions that are involved in its designation. Here, we talk of the type of customers, their needs, difficulties as well as understanding issues related to their partners as well as their failures in satisfying these customers. According to Teece, (2007), the idea of synthesizing is regarded with respect to the dynamic capability model as sensing since it involves stock taking, sharing as well as sensing all the opportunities in the observation phase. For instance, searching data, business partners as well as categorising some repeated issues from the first stage which is discussed by Beckman and Barry (2007) to be frameworks of building a new model. Thus, synthesizing as explained by Lawson, (2006: 37) is "an attempt to move forward and create a response to the problem—the generation of solutions".

Furthermore, creating and designing solutions to potential business model is referred to as the next phase of designing process which is either modifying the previous business model or else creating new ones from scratch. This stage is confirmed by Beckman and Barry (2007: 43) as being the most recognised and implemented exercise with reason being that it involve a wide collection of available techniques in generating new ideas, which range from a rational point of view to instinctive (such as brainstorming). This phase is said to be reflected in the model of the dynamic capabilities corresponding to seizing which as explain by Teece (2007) involves the designation of the structure and the events of an enterprise as well as the business model in order to satisfy customers and capture value.

In the next stage of designing the procedure of business model, we have refining which in this case involve aspects such as the combination of previous designed business models into different classes; evaluate them by using appropriate standards (for instance, feasibility, viability, and desirability. Brown, 2009) then prototyping them through small scale experiments for feedback in the market. This phase reflects the model of dynamic capability as in sensing (prototyping) as well as in seizing (consolidation and evaluation). As suggested by Liedkta and Ogilvie (2011: 113), "whereas brainstorming is best done by a diverse group that includes people outside the innovation project, concept development requires a dedicated core team." This stage which aims at reducing the design opportunities, has to be seen by the team as a complete design solution, supported technology and products, target customers as well as a mechanism to create and capture value revenue model which according to Teece (2007) forms the micro-foundations of seizing opportunity.

Finally, as proposed by these author, the last stage of the procedure in designing a business model which is said to be the implementation phase involve actions such as the putting in to action all the elements proposed by the new design including the activities, structuring (linking the activities) and governing (partnerships) the business model. These activities are reflected through the lens of dynamic capabilities model as the seizing cluster of higher-order capabilities which according to Teece involved the safeguarding of access to capital and human resources. Also, the modification of the stock of resources and capabilities being it by shedding some, deploying some as well as creating or acquiring new ones (Sirmon, Hitt, and Ireland, 2007).

In addition, managers are said to exercise their full leadership here by building loyalty and commitment to the new business model in order to enhance their legitimacy and efficacy in creating more value (Teece, 2007; Snihur and Zott, 2014). In that sense, observed through the lens of the model of dynamic capabilities, the "sensing" cluster of capabilities is again significant as a part of seizing opportunity.

Thus, in our context, we can also assert that concept of DC is linked to BM of the university through the implementation of the various strategies that are put in place by their TTO. In this case, we mean that, for a TTO to effectively design and apply a good business model which can be beneficial to the entire institution, some internal practices must be examined and carefully analysed. For instance, the competences of the staffs, the degree of management and control, decision making and processes. The above-mentioned concepts are what Teece and other authors (Amit and Zott, 2014) refers to as being the dynamic capabilities. In a nutshell, for a university to effectively implement a well design business model, they ought to possess some level of dynamic capabilities which shall help for a better implementation.

3. Methodology and method

This research as earlier mentioned in the introduction aims at understanding the role of dynamics capabilities in the implementation of a business model. It also appreciate the evolution of business model in the university technology transfer office (UTTO) which is a growing concept that is under researched in the literature of business model especially at the level of the TTO (Gartner and Birley, 2002; Dana and Dana, 2005). This approach provides us with the flexibility to cross-examine the business models adopted in this case within the university context. Though there appear to be no complete or holistic models of a framework of university technology transfer in the current literature, the case studies used in this research permits us to develop a framework that directly link the university with the knowledge transfer.

A qualitative methodology was deemed necessary in carrying out this research since according to Yin, (2009) ease the understanding of the dynamism involved in these phenomena. This methodology also generates a longitudinal understanding especially in the evolution of a business model (Langley, 1999; Miller, 2014). Furthermore, Qualitative research seeks to answer the ‘‘why’’ and ‘‘how’’ questions which in the case of this research will provide some inside on the role of dynamic capabilities in the evolution of business model in the TTO (Nastasi, B. K., & Schensul, S. L. (Eds.), 2005).

Considering the aim of this research, a case study was necessary which have for over the years' experienced some significant changes in its principal activities and as such ensuring a sampling strategy which is more focus (Patton, 1990). In this situation, a comparative case study was selected due to its interest in the historical background of its detail characteristics (Gerring, 2008) as such helps in the enhancement of both the theoretical and empirical studies (Edquist, 2005). The selection of a suitable case is considered as a key step in the development of a robust case study which permits to gain a deeper understanding of phenomena that are still not well researched (Gibbert, Ruigrok and Wicki (2008).

Referring to the definition of a case study by Robson, (2002, p. 178), it is a "strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence". Though case studies according to scholars has a limitation of not generalising situations, the business models of organisations are said to be unique entities which have emerged thanks to previous strategies and structures put in place (Flyvbjerg, 2006). This study was carried out with focus in Europe and more precisely in the Balkan area (including Italy which is in the Baltic area). The research protocol was carefully designed and came out with the number of countries, universities and the TTOs to be interviewed. Table 2 shows a summary of the technology transfer office that were interviewed.

3.0 Brief introduction of the six cases to be analysed

This section gives an overview of the of the respective TTO that were interviewed. Here, we shall try to know more about the TTOs by taking in to considerations some aspect such as the age of the TTO, the reason for its creation, the number of people working there and how long they have been in these positions, what they do and for how long they have been carrying out such activities.

3.0.1 The institute of chemistry Ljubljana

The institute of chemistry is regarded as one of the largest research institutes in Slovenia and is the only one chemistry related sciences with about 300 people and over 70 years old. The technology transfer activities have been going on for about a decade but technology transfer office (TTO) as an entity was formed in 2016. Before the creation of this office, it was first called innovation committee made of senior researchers that were experienced in innovation, commercialisation, and legal supports.

End of 2017, the government of Slovenia allocated a large sum of money for the next five years to establish and strengthen TTOs and the public research organisations (about five million for five years for all organisation). From this budget, the institution had a small share which enabled the formation of the TTO. Thus, as an office the TTO is quite young but as an activity within the TTO, it has been going on for a while without any specific focus as there was no dedicated people only for that. The office is made up of three staffs, the first (who is the head of the office) joint in December 2017 while the other two staffs joined the office in March 2018.

This office carries out numerous activities as they have come up with a five-year project strategic document on what methods to be used as well as goals that are expected to be achieve.

Although all the staffs are involved in lots of general activities, each of them do carry out specific projects. For instance, they do a lot of internal and external marketing education, commercialisation, pipeline activities. The head of the TTO is directly responsible for working with researchers in drafting patent applications, filling patent and communicating for the patent persecutors, such as the lawyers and the external patent detainers. Meanwhile, the other two staffs are more responsible in building connections. That is, finding the markets and looking for strategic partners for co-development. One of them is also specialised in encouraging scientist in carrying out their research activities. For instance, having a one on one contact on how to guide researchers to establish spinoffs then try to arrange contracts between national institute of chemistry and other potential entrepreneurs.

3.0.2 the university of Ljubljana TTO

The TTO started in 2006 when the university had this internal role of invention that is, all invention had to be disclosed in this office, though the TTO did not grow till after 10 years of creation. Due to limited activities in commercialisation, this TTO was then established to protect the disclosed knowledge according to the internal role of invention in the university. One other motivation was the availability of the funds which triggered the creation of this Office. However, the knowledge generated in the university was never intended to be commercialised by the TTO.

Initially, the office had 3 employees. However, one of these staffs was not fully working at the office but covering the research and projects which limited the number of staffs to two. However, this number of staffs were not enough to cover the entire university. Consequently, there was not many activities on the commercialisation part although there was some minor reviewing as well as drafting some cases for licensing. Thus, the office was focus only on the protection of the patenting after its disclosure. It was only after July 2017 that 6 other staffs joint the office making the number to be Eight in total.

These staffs came from diverse study background. That is; (2 lawyers, 1 electrical engineer PhD, 1 bio chemist PhD, 1 entrepreneur, 2 marketers and 1 promoter with most of them having PhD). In September, the TTO had this consortium project which started by setting up strategies on how and who to employ and the focus here was mostly on the commercialisation sector to keep in contact with companies both national and international. This was possible thanks to the diversity of the staffs and their various field of specialisation which was combined to better the office.

Primarily, this TTO acted as a central service for all the 36 faculties in the university by reviewing and drafting the licencing agreement and the protection of knowledge created. The office started by building strategies on how to employ new staffs, cooperate with companies or international institutions, carry out contracts drafting and help in the creation of spinoffs. The office also assisted researchers in the firing of patent and for those not fired by the office, they gave directives to the researchers on how to carry on with the activity. The office also searches for national companies and links them to their researchers of which in the past, they only negotiated but did not search for potential partners. In addition, this TTO also have incubators permitting them to produce great researchers and now are looking forward to building a website.

3.0.3 the TTO of the university of Rijeka

The TTO was created in 2009 within the science and technology project which was financed by the loan of world bank but started operating in 2010 (that is, about 10 years old.).It is also part of the university rectorate and the intellectual property (IP) policy was adopted by the university senate in 2009. The university aims at combing all activities regarding the TTO. With respect to the infrastructure, the TTO is located on campus in the science and technology park (which is a limited liability company with majority of its shares own by the university of Rijeka). The university also have the IP policy and university strategy which one part is dedicated to the technology transfer activities as well as the innovation strategy which was adopted by the senate and developed by one European project that got finished in 2012.

This TTO was created because of the available opportunity of loan from the world bank. Through this funding, it was able to show to the university their capability and how they could impact the society. This further gave the opportunity to the TTO to identify and protect the IPs of most researchers who might not have had the idea of carrying such an activity. In total, there were three staffs, but one was the legal person and was considered as part of the rectorate making the number of staffs to be two. The head of the TTO (who also worked as a communication manager in another project) started working in this office in 2011 whereas the other two were already working as TTO staffs from 2009.

With respect to what they do, this office try to identify the Intellectual Property (IP) and research results which are carried out in the university, analyse them and look for best means through which they can be protected and later commercialised. They also work together with the science and technology park. Thus, the main function is to combine all the activities regarding the TTO within the regulatory agreements. This office also establishes all protocol and all procedures needed in the functioning of TTO (by 2012) and had already found contacts on how to carry out patenting activities and at that time we have had about three of them. The TTO also have a campus in science and technology park which is a limited liability company with a majority owned by the university of Rijeka. In addition, this office also has some commercialisation fund which was provided to researchers to encourage them to carry on with much research.

3.0.4 The TTO of the university of Udine

It was created in 2004 under the name of researcher promotion. The aim was to create opportunities for researchers to exploit their research results. Creating spinoffs and filing patents were the main activities of this office. they also search for ways through which these patents could be used in the companies. In 2016, the research centre was connected to the TTO office and they tried to change the vision of the office. This is because the office did not only create spinoff and setups, it also generated opportunities to linked researchers to companies. These changes were delegated by the Rector as he had a good relationship with companies and as such focused the attention of this office to service for students and degree holders by moving their attention to companies which led to the merging of the two (that is: career centre and technology transfer). Thus, the TTO is made of Career centre which focus on students by

offering them service (as the office was more of service) and the PUNTO IMPRESA (which focuses on the relationship with companies like buying patents).

This TTO as earlier explained was created to harmonise all the activities of the university in to one for better exploitation. In 2004, there were three people working in this office with one assistant and a trainee. That means five. Whereas in the patent office there are four people. One administrative and three researchers and an assistant. The office takes patent to companies and ask if they need the technology (that is, it is more of inside-out). The office also links researchers with people to collaborate. Also, Patent office (which is independent from the TTO) works only with patent. However, whenever they have something, they go directly to the companies. Also, they mostly invite companies to link them with their researchers (more of outside-in).

The university is in the research areas with different offices, student office, project office and the communication office. It also has many delegates with each having a different function or sector. There are three delegates, one for spin off, one for patent one for the relation with company. These delegates (about 50 or 60) were intended by the rector to make the work easier. However, there is only one delegate since they have merged with the other offices. There is specific delegate for specific issues as the TTO's aspect is so complicated to manage.

3.0.5 The TTO of the university of Trieste

The TTO was establish in 2008 with the name 'ripartizione' since in the past years, the university started a project call 'start-cap' about entrepreneurship as a business plan competition. They saw it necessary to also internalises some competences about the creation of start-ups and spinoffs lines of development. However, the rector decided to set up a TTO office. By then it was only one person working in the office but within the year, the other competences were merged to strengthen the office for the intellectual property protection. The IPP started in university of Trieste in 2002 with the first patent filling owned by the university. This was performed by our science park with the "SISTA" project but founded from the region which was devoted to help public bodies to file their patent and working on IPP. Thus, patent protection and start-up creation were the first two steps in university technology transfer by the University of Trieste.

The TTO was established first because of the need to internalise certain competences which were not well developed in the university such as start-ups and spin-offs and secondly to resolve the issue of overlapping between the creation of start-up and patent protection. This office is made up of 10 staffs. They carry out patent protection and patent filling, facilitate the creation of start-ups and spinoffs, and are also involved in several projects through the science park such as the SISTA projects.

3.0.6 The TTO of the university of Vilnius

The TTO was founded in 2014. So, currently it is 4 years. Its establishment was considered as an Internal motivation to the university, and the willingness to expand the university starting from regional and moving out. This expansion for instance came through the networking with companies which let the university to benefit from international projects

(such as contracts, contacts, networking activities, broad and new markets, opportunities for both scientists and the TTO). 5 people work in this office, 3 permanent and the 2 others who are hired on specific projects. The head of the office has been there since 2014 (since its creation), one other colleague working with entrepreneurship came in 2015, then another colleague who works with the patenting and licencing joint in 2016. There are also two others who mostly work with projects when necessary.

The TTO was aimed at putting together the processes which were already going and that were somehow scattered and not well coordinated. Thus, the putting of the various processes in one window, also the Patenting and licensing from science department was so that they can provide help to both scientists and business partners.

This office offers services to university staffs and scientists, both international and national mostly through research contracts and grants which is beneficial to the university. It has the initiative to contact national and international companies. For instance, research contracts with international company from other countries. The office also searches for external partners from other universities or companies abroad who are preparing to come and establish in the country. Patenting and Licencing activities in the past were not that pronounced, but in recent years, it is more frequent as the office fully engaged in these two activities. Apart from the TTO, the university also owns a science park and a civil engineering science centre with one salesperson who sells to both national and international companies

Table 2. Details of the interview

Country	University / TTO interviewed	Number of people interviewed	Duration	Month	Position in the TTO
SLOVENIA	- Ljubljana; - National Institute of Chemistry -University of Ljubljana, Ljubljana	2 2	58:34 1:13:46	DEC. 2018 DEC. 2018	TTO Head & a Staff TTO manager and 1 staff
CROATIA	- University of Rijeka	2	55:31	DEC. 2018	TTO Head & a Staff
ITALY	- University of Udine - University Trieste	2 2	45:19 57:19	MAR. 2019 FEB. 2019	TTO Head and Staff TTO Head & a Staff
LITHUANIA	-Technological University of Vilnius	2	47:03	DEC. 2018	TTO Manager & Staff

Table 2. Universities and TTO to be interviewed and those finally interviewed

3.1 the modalities of conducting the interview

The table depicts the number of universities that were interviewed. We started by searching if these universities have a technology or knowledge transfer offices or an equivalent. For those universities that we could not find more information on whether they had this office or not, emails were sent to them which were gotten from their official websites. At this stage, the first set of emails were then sent to each TTO where the research aims were presented and request for their interest to schedule an interview. After these universities showed their interests, a second round of emails were then sent the dates and time for interview were scheduled.

In addition, the choices of the universities involved in this research was due to their proximity (Geographical location) and to facilitate the exploration of contextual differences which is currently lacking in innovation research (Wright 2014; Autio et al., 2014; Mcdam et al., 2017). Furthermore, the aspect of availability of the university (TTO) to be interviewed was also taken into consideration in the process of selection. The research adopted a cross sectional perspective, consisting of data in the first three years of the creation of the TTO and the present date as earlier mentioned. This helps alleviate limitations of existing business model research which often describes a business model at a single point in time and thus fails to capture developmental aspects (Demil et al., 2015).

This interview was carried out by carefully designing an interview guide which was presented to the selected technology transfer offices for interview. Before commencing with the interview proper, the attention of the correspondents was drawn to the fact that a tape recorder was to be used to enhance the experience of the interviewer during the transcription. This interview that lasted for approximately 48 minutes per candidate was designed in two parts, with the first destined to interview the head of the TTO (which in this case was the manager). This part tries to understand the overview of the formation of this office, why it was created, how many staffs, what they do and for how long the office have existed and if there were some external influences in supporting it creation and activities.

This was immediately followed by an ‘annex 1’ with a list of activities they might have been carrying out for the past one year more and if these activities are still carried out today. This feedback provided us with some information on the main changes that occurred in the past three year from its creation till date. For instance, the geographical scope and the breath of the activities of the TTO one year after its formation and today which made us to understand what the extent of the network of contacts is, and the extend of the activities carried out by the TTO. However, even distant contacts can be activated passively or actively. That means that TTO can “reach” others or “being reached” by others. Or simply be a gatekeeper between well connected researchers and clients all over the world.

In addition, the scientific scope of the TTO was also mention which provided some information on if at the beginning the TTO was specialised in a specific scientific domain? (biotech, IT, robotics, etc.) Or not. With this information, few more questions were asked to know to what extend the head of the TTO agreed or disagreed with certain statements concerning the regulatory, cognitive, and normative dimensions. The second part concerns the dynamic capabilities which constitute the backbone of this research. Here, the study tries to understand how this concept have influenced the implementation of the business models in the TTO drawn from previous works of researchers (Gupta et al., 2004; Teece 2016 and 2018). Here, the interview was directed to one of the staffs working in the TTO order than the head of

the office. This was to avoid self-assessment since most of the questions posed here involved the ability of the manager to overcome certain challenges. This is referred to as the ability to define and specify highly challenging but realistic outcomes for the TTO people to accomplish.

The analysis of this data proceeded in an interactive manner as the respondents provided detail information about the questions that were asked (Miller, 2014). Some of the responses provided by the respondents further prompted some additional questions on how and why the phenomenon that they explained or the action that they took affected the TTO. By referring to the literature concerning the research area on which the interview was conducted, this refreshed the minds of our respondents stay into context according to the research which greatly assisted in the analysis of the data (Yin, 2009). The various means employed as well as the interactive process used in collecting information from the respondents were through direct (face-to-face) interviews, the use of a tape recorder as well as some documents and reports from other sources. This resulted to a combination of suggestions using data triangulation which facilitates the data analysis and improve on the limitations involved in carrying out a case study research (Creswell, 2003; Saunders et al., 2007; Konecki, 2008).

4. Data analysis and Results

4.0.Data source

This analysis as earlier mentioned is a multiple case study carried out in 5 selected universities in Europe precisely in the Balkan and the Baltic areas including Slovenia, Lithuania; Croatia as well as Italy with at least one university from each of the afore mentioned countries. This study was carried out from 2018 to 2019 in the form of an interview which was conducted in technology transfer offices (TTOs) of these institutions. This project tries to analyse the relationship that exist between TTOs in the Balkan as well as the Baltic areas in terms of the evolution of their business model and precisely the role of dynamic capabilities in the implementation of this model. This is confirmed by Abreu et al., (2008) as the author explains that case studies aim at capturing a wide range of activities permitting to understand the implementation of business model in universities.

With respect to the sample frame for this academic research, the Balkan area was included for reasons already mention above with selected countries including; Slovenia (the university TTO of Ljubljana and the National institute of Chemistry); Croatia (the University TTO of Rijeka), Lithuania (University TTO of Vilnius) in addition to Italy (the university technology transfer offices of Trieste and Udine). The data was conducted by carrying out an exclusive interview with both the head of the offices as well as one of their employees to avoid some biasness that might have occurred in interviewing only the manager.

The information about the availability of these participants were gotten through regular emails that were sent to the universities where some of them responded and some could not dues to one reason of the other (on holiday, late responses, incomplete response), thus reducing the sample. Though this is an ongoing research, the total number of universities that were finally interviewed 3ewere six, and some results were obtained which shall be analysed in the next section. This analysis according to the research shall take place in two-fold. Firstly, with respect to the three elements (sensing, seizing, and reconfiguring) that makes up the dynamic

capabilities as explained by Teece and secondly with respect to their activities carried out at different levels of the TTOs.

4.1 Analysis of the case studies

As already explained by Teece in his framework, the idea of sensing, seizing as well as reconfiguring forms the basis of Dynamic capabilities concept. By applying the concept in this piece of research, the focus shall be on the technology transfer offices which has already been mentioned As such, this research seeks to verify if the representatives of the TTOs that were interviewed in the six universities implement the three above mentioned concepts in their respective TTO. Here, we shall try to analyse each case at once and describe how the three dimensions of DCs have allowed the TTO/KTO to promote an evolution of their BMs.

The National Institute of Chemistry in Ljubljana vision that they could improve on the innovative activities of the entire institution by assisting each department depending on their needs. That they could at the same time sell their services (mostly technology transfer activities) to these faculties which improved collaboration also with the companies. These activities also prepared the TTO ahead of time towards the five years funding program initiated by the Slovenian government. This funding is offered to all institutions depending on their activities and plans to boast and encourage the development of new technology or knowledge.

It has thus helped the TTO to widen its scope of activities by increasing the number of experience workers from various fields of studies. Also, by introducing new activities geared at further generating income to the office, thus enhancing the implementation of either new or existing business model. This idea of visioning and anticipating funds for technology development is in line with the concept earlier proposed by Teece which involve sensing by mainly identifying technological opportunities as well as technology development.

In the same light, a lot of support has been carried out in the domain of innovation competition at the Institute by motivating the researchers to apply for competitive prices which have been very successful for the past years. As a positive outcome, researcher (thanks to the competitive program) have caught a lot of media attention and prices which has enhanced the experience of the institution as it is a sort of a chain reaction. For instance, the researcher obtains grants together with the company offered by the chamber of commerce thanks to their timely interventions in seizing such golden opportunity which has enhance the business model put in place. However, this TTO sometimes finds it hard to manage the program both at the national and international levels which is something that they are still working on.

Nevertheless, the biggest change as express by this Institute results from the funds dedicated for developing the TTO office since people could have the time to think of better strategies on how to engage new capabilities. For instance, the TTO funding now (which is being carried out in a systematic way) has been shifted from two to five years as a consortium project which is operated in partnership with other faculties and all the public research organisation. This has increased both the funds and the activities of the TTO and has given room to better develop and implement new business models. This is because, technology knowledge transfer in this institution was basically focus on research and development (R&D) with companies. As such, there were some spinoff in the past, but has in recent years played a more active role on spinoffs marketing ideas which has broaden the activities this office. Due

to limited funding, new projects and contracts have been created of by the TTO to self-fund their project as the management of the institution expect that part of the funding needed by the office should be self-created.

Furthermore, the possibility of sharing technological ideas which have greatly improve the business model implementation is through Coffee breaks which are regularly organised by the staffs of the university of Ljubljana as well as those of Udine. These meetings prepare some opportunities to get into contact with other researchers in different fields as well as some company friends who provide them with some useful technical information on better options. For instance, designing research projects, share ideas on the opportunities of obtaining or transforming new technologies as well as carrying out some trainings which could enhanced the technical knowhow of the staffs.

However, most of these funding (as explained by some of those interviewed) destined for these projects comes occasionally. This irregularity disrupts the smooth functioning of some of the technology development activities of the TTO since some future projects might not be funded. Thus, the concept of seizing opportunity (which according to Teece is destined to Designate and refined good business models as well as committing resources to yield a maximum output) is partially implemented at this level.

This phenomenon has forced the TTO to develop new capabilities and new ways of developing their technologies from their own personal experiences in addition to some advices from some Western experienced professors to better organise this office. Meanwhile the TTO in Udine have seized the opportunity of involving companies in developing their technology (knowledge) transfer activities by launching for instance another activity called the multi-company PhD. This projected demands professors to propose research themes which are presented to companies and if interested, could be the donors with a little fee per year that could sustain these researchers. These proposed themes have greatly enhanced the development of good business models to be implemented since the ideas come from different researchers with different research backgrounds. Thus, this goes to confirm the fact that the idea of sensing opportunity is fully applied to the university of Udine as they are mostly involved in identifying opportunities such as technological possibilities to fully develop their technology.

Likewise, in Udine, thanks to the introduction of the competence centre (a service introduced in the office with the aim to create opportunities for researchers) in the TTO in 2016, the university had acquired lot of contact with companies for placement and so it was an opportunity that was seized in using these contacts for other important activities. For instance, exploring their research results, creating spinoffs, filling of patents, and making sure that these patents are used in companies. This collaboration with companies has helped the TTO to receive lots of reports from the companies, meet with them and propose solutions to their needs. It also assisted in organising events, propose new services to companies as well as job events that could bring together students, researchers, and companies. This has enhanced the experience of the university in the creation and implementation of new business model geared towards this collaboration.

Furthermore, the university of Ljubljana also witness some great changes in their administration with the introduction of a new rector. For instance, there has been an increase in the funding as the TTO can now boast of bringing in foreign experts to participate or organise international projects. These projects are mainly on technology transfer activities to bring up

new ideas of how to improve on the development and implementation of good business models. It also helps in the protection of IP which was something that the office could not boast of in the past. With this available fund, almost all the IP of their researchers can be managed and protected from competitors as well as help them to fire more patents.

As explained by this TTO representatives, they have seized the opportunity to work hard to prove to the Governments that they are up to the task. For instance, due to their good experience in the field, they have brought in new and more interesting projects which have convinced the Government to allocate them more fund and has greatly enhance the implementation of new business model. Nevertheless, some faculties have greater ambition than others depending on how they operate (since they work independently). Thus, making it difficult for the university or the TTO to broaden its goal as the Indicators are mostly set by governments funding.

Thanks to the increase in the number of staffs at the university of Ljubljana TTO, this effectuated some changes in the office as their activities gradually moved from being passive to being active as well as shifting from less capability to more capability. These changes also led the TTO to develop some strategies that permitted to acquire funds from the governments and from external partners. This funding authorized the office to employ many staffs and took care of their research activities. These strategies also permitted the office to evaluate the performances which have increased in recent years.

However, there has been some conflict of interest of researchers carrying out their jobs and at the same time engaging into entrepreneurial activities. This issue could be address in future research by the university authorities through some roles put in place to govern these researchers. This concept as highlighted by Teece deals with the transformation or realigning the structure and the culture of the institution. For instance, either by realigning existing capabilities or by investing in new capabilities mostly from outside the organisation.

Moreover, with the introduction of the institute of civil engineering in the university of Vilnius, their TTO have seized this opportunity to better develop and market their Intellectual Properties or knowledge to resourceful businessmen. This is because the institute has long relations with companies who come directly to the researcher in search for partnership due to their long-lasting cooperation with businesses and their expertise in the field of developing and transferring technology. Also, thanks to their long history of corporation with businesses due to longevity, quality of service and their expertise in the field. This huge market coverage has also projected the future of this TTO since it will be hard to work with IP which might not be relevant today. For instance, no recent invention of bicycles as was in the past but the putting in place of new models permitting to come up with new technologies such as the production of sun driving, electrical cars and many others.

Most TTOs have thus used this opportunity to identify with all the experts in both the academic and business sectors to better organise their offices. For instance, this idea has given the university of Rijeka the opportunity not only to develop new technology but as well to fully protect the Intellectual Property which have been and yet to be produced in the university. This project according to TTO of Rijeka has been possible thanks to the opportunity of the availability of funding (loan) from the world bank. According to them, this has not only encouraged the creation of the TTO but has greatly improve in the development and the

management of new knowledge in the university since the TTO have long sense and prepared for the opportunity.

In addition, with this funding (loan) from the world bank, the TTO have seized the opportunity to protect the IP of its researchers which has brought in more money to the university. This is because these IP could not be easily copied. The TTO of Rijeka was also created thanks to this loan which later was able to show to the university their capability and how they could develop new business models and impact the society through the transfer of this technology. This further gave the opportunity to the TTO to identify and protect the IPs of most researchers who might not have had the idea of carrying such an activity.

Here, the TTO tried to identify the IPs and research results, analyse them, and look for best means through which they can be protected and commercialised. All this activity is facilitated thanks to the partnership with the science and technology park. This idea goes in line with what has been proposed by Teece as opportunity seizing which involve Designation and the refining of good business models as well as committing resources to yield a maximum output. This can be seen in the university of Rijeka as earlier mentioned where they have identified with some of these aspects which have help in managing and protecting the IP Researchers.

In the university of Trieste, certain competences were not well developed from the start such as start-ups and spin-offs. Also, there was this issue of overlapping between the creation of start-up and patent protection. The university seized this opportunity to create a TTO which was to internalise these structures, generate opportunities as well as create and implement new business models. In addition, there was a huge push from Central and regional government at the same time as they were funding some activities and projects which could not be handled under education and development.

For instance, funding was allocated to 22 research assistants while the TTO office was busy creating links with the companies to find the right solution in terms of technology as well as identifying those to perform this research. This was a project meant to link scientists and companies by providing this new figure of research assistant making the scientist to spend some time in the companies giving them an advantage over the adversary. Also, thanks to the creation of the NETVAL project (an association of TTO) in Italy where they meet once per year to understand researcher's problems and propose possible solutions and ideas for developing and implementing new business models. This has given the TTO of both Trieste and Udine some new roles on how to better develop and implement new business models in the TTO.

The NETVAL project also generated some new roles to both the TTO of Trieste and Udine on how to better implement the concept of technology transfer for better organisation. Overall, these TTOs have been greatly involved in sensing as well as seizing opportunities which have greatly enhanced the activities of the offices. From the above explanation, there has been less involvement in the reconfiguration of these office since most of them are either newly created or are still open for new experts from different fields of studies. Also, because most of the staffs are drawn from various background and sometimes finds it a bit difficult to galvanise their activities (within the first few years) towards one direction due to some conflicting ideas that could occur in managing or changing of projects.

Nevertheless, the creation of TTO at the University of Vilnius brought about new procedure for patenting, Intellectual Property managements and licensing. That is, they seized the opportunity of developing new strategies and action plan from the inception of the TTO. For instance, whenever scientist came up with a new technology, a new strategy is defined by the university (usually senate and rector) together with TTO and making sure that it is a top down approach (with main decision maker being the rector). Some of this strategy is to look for new resources and new research laboratories to engage with these facilities and use them to improve on the expected results. This have given the opportunity to the TTO to develop and implement new business model that could help in putting these new strategies in to place. To finalise this, the TTO is always very kind to the researchers by talking to them about new possibilities with the aim of bringing stability (a balance) in the activities.

Similarly, the encouragement of being proactive in the TTO of Vilnius came from several aspects such as: Comparing with other well renounced TTOs; Always open to new ideas from outside the TTO; copying good examples from seminars and workshops which are organised by high standard European institutions. For instance, these organisations provide the TTO with lots of trainings on several activities namely, licensing, pricing, negotiating and much more. This has enhanced their capacities as well as encourage them in developing and implementing new business models.

In addition, experienced experts from big companies, institutions or organisations occasionally comes to the university and train most of the researchers and TTO staffs which intend enhance their professional skills. Though, each faculty in Vilnius University has its own strategy, only the rector and senate decide on the overall strategy for the whole university including the TTO. Thus, most of the TTOs have seized the opportunity provided to them either by foreign experts or examples from other office to enhance their office by developing new approaches towards the protection of Intellectual Property.

4 Discussion

As expressed by Teece (2018), capabilities are considered more valuable if they can be sensed or identified from the start which permits a better organisation by putting in place better strategies in implementing any new business model. In this case, setting higher standard from the beginning enhances the performance of the TTO as they are compelled to work towards its success. This idea goes in line with the goals that are set by the TTOs, though not all goals were set by all the offices from the start of the office. For instance, in Trieste, the goals that were set were not very specific from the start since there were only two staffs from its creation and as such were more flexible in their activities. This also goes in line with the fact that opportunities might not only be sensed from the inception but could be sized while carrying on the activities like in the case of TTO Trieste.

Also, higher motivations speed up the process of dynamic capabilities because when identified, it becomes easier to capture value which help in determining the architecture or strategy of a business (Teece, 2007). A successful implementation of a new or existing business model as mentioned by Teece must involve the three determinants of dynamic capabilities, though this same model explains that not all three capabilities might be available in an institution at the same time.

Some dynamic capabilities like Information sharing are considered in business as one of the main tools that can enhance the capacity of the implementation of a successful business model. This is because it provides knowledge to those sectors that might not have the opportunity to sense this information. As such, this encourages the members of staff to work towards the vision that has been set by this office either from the start or after its creation. This scenario goes in line with all the TTO representatives that were interviewed, as most of them had their goals set either from the start or after its creation though not all were specified. These goals are set as a result of specific vision that is pursued by each office which encouraged both the head of the office as well as the members of staffs through information sharing as most of them came from diverse background of studies. Thus, this diversity enhances their capacity to be able to harmonise the different knowledge and come up with common ideas on how a new model could be developed and implemented.

In a general manner, the idea of dynamic capability as mentioned in this research has to an extend enhanced the implementation of business models in some of the TTOs which could be seen from the way the strategies are being implemented. For instance, whenever scientists come out with any new technology from their research, the TTO of Vilnius will have to develop new strategies couple with the general strategy that is provided by the university. This strengthened the business model that is or to be put in place by the TTO. In Italy, the TTO of Trieste and Udine have through their dynamic capabilities encouraged their researchers as well as enhanced their technology skills. This is done by either linking them with companies to develop and transform their knowledge to a sellable good or by organising some workshops and training activities. In addition, the NETVAL project as earlier mention has also enhanced the capacity of these TTOs which have contributed in a positive way in designing and implementing new business models or amending existing ones. However, there are some exceptional cases like in the TTO of Ljubljana where they are more of reactive than proactive in their vision of new projects which hinders the development of a new business model.

Though most of the capabilities projected by these TTOs are geared towards the creation of a new business model, not all of them are very useful in its development and implementation. This is because, possessing competences or even resources without any knowledge of dynamic capabilities can only yield short-term competitive returns rather than one that can last for a longer period. However, there are some exceptional such as building competitive defences and shaping the outcomes of technology markets through innovation and business reconfiguration. For instance, the National Institute of Chemistry is more involve into innovative projects where it carries on a lot of internal and external marketing education, commercialisation, pipeline activities. It is also responsible for working with researchers in drafting patent applications, filling patent and communicating for the patent persecutors such as the lawyers and the external patent detainers. These capabilities have greatly enhanced the activities as well as the experiences of the TTO staffs in the implementation of good busies models.

Overall, the idea of sensing opportunities from the start of the TTOs was not really effective since most of the offices did not have a direct and Constance source of finance that could permit it to anticipate and carry on future projects or develop new technology which could be used for further innovation. That is, most projects in these offices were funded either depending on their performances or on the availability of funding from either the university or the Government. Therefore, it must develop new means or business models to generate more income for its activities. A good number of the TTO actually sized most of the opportunities

that were available at their disposal some of which include; making use of the funding, organising coffee breaks with others, constant collaboration with companies and the creations of links for trainings as well as participating in innovative workshops. Reconfiguring new or existing business models by TTOs was also not very common since most of these TTO were young with only few staffs (maximum 5) who were drawn from diverse academic background. Whereas on the other hand, the TTO of Trieste had up to 10 staffs who came from different discipline with different ideas and visions.

4.0 Theoretical contributions

The concept of Dynamic capabilities as stipulated in this paper is the framework that can enhance the abilities of managers with respect to when and how to manage both the presents and the future unforeseen circumstances. As earlier mentioned, this framework helps bring together the rudiments which determine when a quick investment can be carried out to overcome or minimise the risk involved in transferring technology. Thus, this paper contributes to the existing literature in many ways, firstly, the study demonstrates that in adopting a good business model in the TTO, some roles of dynamic capabilities (which in this case include sensing, seizing and transforming) must be applied. This shall go a long way to facilitate decision making among managers or decision makers in the TTO. Secondly, this research also contributes to the existing literature by analysing the relationship existing between business model and the dynamic capabilities which is essential for future research in analysing these two concepts. Furthermore, the research has also come up with various definitions as to what business model is about which makes it easier for future researchers to have easy access in analysing the different definitions depending on the field of studies.

4.1 Practical implications

With respect to most cases, the arrival of a new technology provides more openings in developing innovative business models that in the long run make these TTOs to be more proactive in their activities and as such protects the intellectual properties which are generated from within. However, the top management are sometimes faced with the conflicting interest of both the strategy put in place as well as the newly adapted business model. This conflicting idea is easily resolved by the implementation of the dynamic capability framework independently as it forms the core of the new business model. This is finalised by reforming or carrying out some improvement in the TTOs by either transforming them to operate fully under the universities or by enhancing and empowering them to be more independent and more focus on generating money to the university. This could be achieved either by readjusting the structural composition of the technology transfer offices in line with the cultural aspect of the university. To be more practical, technology transfer offices could align the already existing capabilities and improve on them to maximise the result of the existing business model in place, or invest in new capabilities such as carrying out new routines or bringing in new expert from outside the university with new ideas and methods of operating the office.

In addition, Rumelt, (2011) in his definition of strategy, outlines some challenges that can be faced by TTOs resulting from competition among other technology transfer offices in different universities. In carrying out a successful strategic analysis, TTOs are better placed in

selecting a business model which could determine the success in marketing their technology. Thus, the introduction of a new business models might lead to the replacement of the existing one which as such, acts as a double advantage since the competitors are not familiar with it yet (Casadesus-Masanell and Ricart, 2011). Thus, effective communication and information sharing among members as well as teamwork can greatly improve the activities of the TTO since knowledge is shared to everyone which makes the job easier. Furthermore, performance in the TTO is more effective if the staff members are drawn from various study background with different ideas on how to approach similar problems. Thus, the greater the number of staffs, the greater the capacity of the TTO and consequently a better performance in knowledge transfer activities

4.2 Limitations with future research directions

Though the research was based on a case study, there were some limitations as to the size of the sample population that was interviewed as some universities did not respond to the invitations on time. In addition, some of the TTO were too young with very few staffs while some were made up of a collection of various disciplines or faculties which made it a bit difficult to conclude on their activities. The finding that some TTOs are more agile than others in carrying out technology transfer activities is because not all the office possesses all the elements that characterises the dynamic capability which intend slows down the rate of implementation of a new business model. This idea was borrowed from Teece, (2018) as the author explain that the implementation of a good business model can only be in the short run if one of the three elements that makes up the dynamic capabilities are missing (that is sensing, seizing and transforming).

Since there has always been limited financial resources in the running of most of the TTO, new strategies had to come up on how to lobby for funds that can help this office grow. One of the ways was to acquire some diplomatic abilities as well as some leadership skill on how to effectively bargain for resources either from the university or the state. These abilities are effectively implemented by instilling confidence in the member of staffs to work as a team for a better result though according to this research, not all the TTO were highly engaged in these activities from the start. The reason being that universities generally work but on project base financed which comes mostly from the government and from contracts with companies (either national or international).

This research could further be developed by going beyond the Balkan area to have a much more global view on how business model has evolved over time. Since some researchers manage their inventions with little or no assistant from the university of the TTO, future research may perhaps try to understand the perception of researchers around the world on the reason some do not passes through these offices to market their newly created inventions. Nevertheless, some authors after long years of research concluded that “a Strategy has been the primary building block of competitiveness over the past three decades, but in the future, the quest for sustainable advantage may as well begin with the business model” (Casadesus-Masanell and Ricart, 2011: 100).

5 Conclusion

This research has been aimed at understanding the evolution of business model and more especially the role play by dynamic capabilities in the implementation of this model in the technology transfer offices (TTO). The framework of dynamic capabilities used in this research is borrowed from the works of Teece, where the authors explained the most important elements constituting this approach. More practically, dynamic capabilities can further be broken down into three sets of activities, that is, sensing opportunities, seizing them as well as transforming these opportunities to attain the required results. This approach integrates how academic institutions are designed as well as the strategies put in place to better implement a specific model. Research also shows us that, TTOs with staffs drawn from different background can be more effective in developing and implementing new business models or ideas which is regarded to be of significant to the entire university.

Thus, it provided an overview of the TTOs as well as its role in the transfer of technology from the university to the technology market. Also, most of these technology transfer became intensified in universities thanks to the liberation of this sector by the government mostly in the 80s where universities had the opportunity to create technology transfer offices to market these new inventions. Research have also shown that, most of these TTO were not able to carry on well with their activities due to limited fund, as such had to develop mew means to generate additional income for the daily running of the activities. Then the idea of developing and implementing new business model was mentioned by some researchers who later came up with some ideas on how to better implement these new business models. As such, the idea of dynamic capabilities comes in to better explain how this implementation can be possible in the context of university technology transfer offices.

6 Appendix

Annex 1.

	EARLY STAGE *1 YEAR AFTER SET UP*			***TODAY*** *N YEARS AFTER SET UP*		
ACTIVITY	YES	GEOG. SCOPE OF NETWORK*	ACTIVE/ PASSIVE ROLE	YES	GEOG. SCOPE OF NETWORK*	ACTIVE/ PASSIVE ROLE
- patents filing (support to)						
- licensing agreements (support)						
- spin-offs						
- start-up competition (organized)						
- workshops and events (organized)						
- entrepreneurship course (direct involvement)						
- research contract (support to)						
- research grant (support to scholars)						
- direct management of scientific parks / incubators						
- managing relationships with venture capitalists and business angels						
- other activities worth to mention?						
…						
…						
SCIENTIFIC SPECIALIZATION	At the real beginning…			Today….		
Was/Is this TTO specialized in a specific scientific domain? (ex: biotech, IT, robotics, etc.)						

* GEOGRAPHICAL SCOPE

The idea behind the measurement of the geographical scope is to understand what the extent of the network of contacts is, and the extend of the activities carried out by the TTO. However, even distant contacts can be activated passively or actively. That means that TTO can "reach" others or "being reached" by others. Or simply be a gatekeeper between well connected researchers and clients all over the world. We must try to understand that going beyond the labels which are just examples.

U = University; L = Local; N = National; R = Regional/Adriatic area; G = Global/International

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Third paper.

Exploring the main drivers of academic frustration: a systematic scale development

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Abstract

Over the last two decades, researchers have gradually moved from the traditional ways which involve teaching and carrying out research to a more advanced way involving the creation and filing of patents as well as the creation of spin-offs which has complicated the system due to the challenges faced by most scholars in managing both activities. This research seeks to deepen the link between the frustration academics may perceive in carrying out their job and their entrepreneurial attitudes, intentions, and behaviours. The research is just the first step of a bigger research which is carried out at an individual level crossing psychological and managerial literature permitting us to understand the main drivers of academic frustration. To address our research question, we carried out a systematic scale development where a survey was carried out with main participants being university professors. A principal component analysis was used with the help of Cronbach's Alpha to determine the internal validity of the constructs used in this research. The empirical results that are obtained so far are just related to the measurement model. Therefore, the results collected from this study are being used in testing the constructs that we decided to use in this research.

Key words: *Academic frustration; Scale development; Frustration; Dissatisfaction; Intolerance; Factor analysis.*

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Introduction

The nature of the global academic profession as well as its culture has undergone significant changes in the past several decades. This has gradually been shaped as well as altered by some major structural developments especially at the level of the higher education (Enders and de Weert, 2009). Traditionally, the main goal of academics was focus on teaching as well as carrying out research, which together have laid down the foundation of academic scholarship. Some authors (Perkin, 1969; Clark, 1987 and Perkin, 2018) have argued that the academic profession can be considered as the 'profession of the professions' since it has the capacity to further shape other noble professions in the society. However, this idea has gradually shifted to a more complex field where researchers now are more involve in the production and filling of patents and at the same time cooperating with companies through the creation of spinoffs in many universities.

In addition, scientific publications, conferences, and the training of well skilled labour force are said to be the main forms of mechanisms through which universities have used in the past to diffuse knowledge. Nevertheless, the commercialisation of knowledge (which is also one of the major mechanisms) is considered very significant in this research. This is because it can further be divided into other forms of mechanisms including patenting, research contracts with industry, consulting activities as well as spin-off formation (which according to Landry et al., (2006) is considered as the major form of university research commercialisation). Therefore, many researchers are now involved into spinoff activities which have in recent years gradually pulled some of them away from their initial academic activities.

The changing nature of this phenomenon have made some researchers to try to manage both their research activities as well as involving themselves in entrepreneurial activities. Top management in academic have identified the need to change, bring to public new strategic initiatives, modify incentives, and divert significant resources to develop supportive organisational structures. However, the persistence of existing routines and older norms of behaviour frequently impede these organisational transformations. Thus, understanding the different levels of the worries of academics is important to appreciate the academic culture in terms of morale, retention, and productivity of academics (Sword et al., 2018).

Nevertheless, the analysis presented by Sword limits itself only to academic writing and does not extend to the second stream of literature which involve the entrepreneurial perception. Therefore, this research is built upon two streams of literature which consist of the positive and negative emotions that researchers encounter or face at their job sides as well as the antecedents of academic entrepreneurship (Baron 2007). The research seeks then to deepen these two streams of literature in order to better understand the perception of researchers on the link existing between academic passion and frustration as well as entrepreneurship activities which according to Cardon & Kirk (2015) Has not been fully addressed by scholars.

Nevertheless, as highlighted by Abler et al., (2005) social exclusion greatly influences the idea of being more creative and active. This idea is supported by Eisenberger et al. (2003) as the authors took the example of a functional magnetic resonance imaging (fMRI) after studying the neuronal correlates of rejection in the social context of an interactive game. These authors came to realise that when rejected in the society, the physical pains can render one to

be more active than before. On this note, we suggest in this piece of work that the idea of being frustrated in life could be a push factor in wanting to create new ventures or better still spinoffs.

Thus, our claim in this piece of research is to understand as well as explore what drives academics to be frustrated to maybe want to move from carrying out their normal duties as academics to engaging in other activities. The research is carried out at an individual level crossing psychological and managerial literature which highly contribute to the existing literature by assessing both the individual and a general view of researchers (mostly professors) in the university.

The rest of this paper is presented as follows: a brief literature and the background of the evolution of academic frustration shall be discussed by focusing on the perceptions of academics who are involve or intend to carry out entrepreneurial activities. The next section shall be discussing on the methods (in this case a survey) and the methodology (a quantitative one) put in place to carry out this piece of research which shall be followed by data analysis as well as the results of the research. Furthermore, some analysis shall be carried out to test the measures that have been used in this research to ensure that they are suitable for factor analysis. The last part shall be the conclusion which shall involve some implications, possible solutions as well recommendations as to how this phenomenon can better be managed by stakeholders in their various academic institutions.

Background

Academics' perceptions of their work environment not only affect their work motivation and psychological well-being (Zhang & Fu, 2019), but also their overall productivity and their growth in the scientific environment (Winter & Sarros, 2002). Academics tend to take in high consideration the psychological contract based on mutual trust and perceived reciprocity with universities. However, when workload is felt to be excessive and extremely time pressuring, academics have a proclivity for reducing their commitment by a re-evaluation of their psychological contracts (Sarros, 2002). The underpinning idea that corroborates to this thesis is based on the pervasive nature of role overload as a potential driver for academic frustration. Scholars identified some main sources of academic satisfaction and dissatisfaction.

In particular, the main sources of satisfaction are related to the teaching activities, to the ones research-related and to the nature itself of their work (Da Wan et al., 2015). Thus, the flexible nature of the work inside Academia involves the decision on how to spend working hours and choosing whether to undertake a certain type of research tasks. Contrarily, the main sources of dissatisfaction deals with red tapes, job progression, evaluation of research, administrative duties, and a substantial lack of resources (Da Wan et al., 2015). One of the possible reasons why academics can lack of motivation and psychological well-being is the level of frustration connected in carrying out their job.

In the psychological field, the concept of frustration is associated to an interior reaction to an obstacle that is introduced between a person and her or his goal (Coon & Mitterer, 2010). Past scientific literature has already developed multi-dimensional scales for capturing the essence of human frustration (Harrington, 2005). Anyway, as urged by Sword et al. (2018), the existing theoretical framework on frustration has not been fully articulated by researchers since it addresses a set of different disciplines that necessitate a specific focus (e.g. the world of academics). And no measure of academic frustration has been developed so far.

Our study attempts to fill this literature gap and to provide a sound, reliable and empirically validated measure of academic frustration. Based on the current conceptualisations of frustration pertaining to a multi-sided literature (psychology, psychology of work, organizational science, management), we develop and validate a multi-dimensional measure of academic frustration following a multi-step process.

In the last decades, the main duties of scholars have been subject to a radical reshape (Enders and de Weert, 2009). On the one hand, pressure towards scientific obtaining scientific publications of high ranking (summarized in the mantra "publish or perish") have dramatically increased. Further, today's academics bear growing responsibilities in communicating and transmitting values to the rest of the society (Da Wan et al., 2015). As responsibility increases, also, the social commitment and pressure tend to intensify their effects on academics.

In a paper by Sword (2017) the word "frustration" appeared as the most generally felt emotion, mentioned nearly twice as often as the next most frequently cited emotion word, anxiety across various disciplines worldwide. According to the author, there is up to now no clear definition as to what "frustration" is all about nor the reason why some academic writers get frustrated. In addition, a review of the literature from fields such as cognitive psychology,

neuroscience and linguistics revealed little consensus as to the causes, the symptoms or even the definition of frustration. In the same way, there is no single study in the higher education literature that exclusively or comprehensively deals with the nature of frustration for scholarly writers, despite a growing interdisciplinary interest in academic studies (Sword et al., 2018).

Both internal and external causes of frustration faced by academics have long been recognised in the literature, especially in relation to the influence played by the social context (Aarnikoivu et al. 2019; Sword et al., 2018; Shenton, 2008). Sword (2018) divided the causes of frustration experienced by academics into internal (ineloquence/craft struggles; inefficiency/poor discipline; difficulty of beginning; length of writing process; writing in a second language; writer's block) and external ones (lack of time; academic conventions; negative feedbacks; lack of guidance/support; academic politics). The above phenomenon is summarised in fig. 1 as shown.

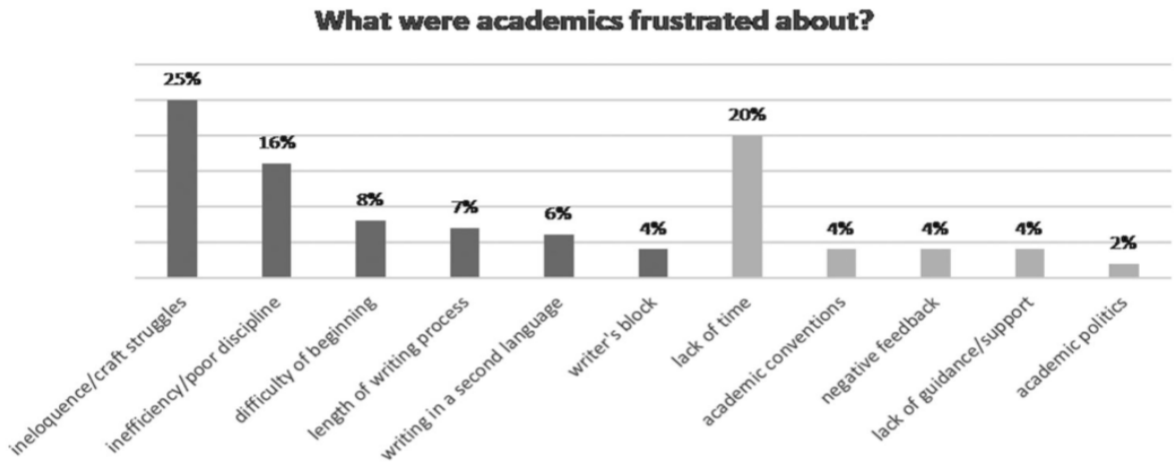

Figure 1. Internal and external causes of academic writers' frustration (Sword, 2018).

Our argument about frustration shall be focus only on academics and entrepreneurship by deepening the understanding on the relationship existing between academics carrying out their teaching and research activities and at the same time engaging in the creation of new ventures or better still entrepreneurial activities. While analysing the data, we shall also look at some of the motivation perceived by these academics as well as their behaviour and intentions in carrying out entrepreneurial activities (Miranda et al., 2017).

Thus, we shall bring out some of the push and pull factors that enable them to engage in such activities. Some suggestions to start a business as already mentioned by Barba-Sánchez & Atienza-Sahuquillo, (2012) shall include main drivers such as the need for achievement, self-realisation, independence, affiliation competence, and power, rather than just for money making or being one's own boss. Though Shaver & Scott, (1992) on the other hand earlier mentioned that starting a new venture does not only capitalises on what pushes one to do so or the opportunities that awaits one in venturing, they are instead more focus on the few that when laid off can create new venture.

As described by Abler et al. (2005), this negative feeling boils down to what they termed frustration, which symbolizes the emotional reaction that follows the delay of either an item or event to be rewarded. It is regarded by other researchers as the "fire of desire" that energies the day-to-day efforts (Cardon et al., 2009). This leads them to keep on mindful the challenge and

difficulty encountered with the adversary and the working environment (Cardon et al., 2005; Cardon and Kirk, 2015).

By considering the working environments, most entrepreneurs are regularly unpredictable and as such bound by some quick change which exposed them to some greater risk. For instance, their responsibilities vis-a-vis the company together with their employees, numerous assignments, and most at times function under severe financial constraints. Consequently, the entrepreneur who is an academic when exposed or faced with the afore-mentioned situations is bound to have a certain level of stress in managing the various situations (Robert et al., 2016). In this context, it can be considered as another level of frustration.

Furthermore, this environmental influence results from networking with the external organisations (companies) is also described by Hayter et al., (2018) as an ecosystem which have greatly strengthen the networks, a variety of organisation and technology changes. Nevertheless, the concept of ecosystem is based on networking activities as well as the capacity to supply both information and resources. This aims at piloting the entrepreneurial environment with its relentless competition which could negatively or positively affects or frustrate some entrepreneurial activities (Adner and Kapoor, 2010; Zahra and Nambisan, 2012).

In the same way as suggested by Hayter (2016b), the framework of academic entrepreneurship could only be more effective as a result of how interconnected the basic elements are and their role in firm's success (Whittington et al., 2009; Leyden et al., 2014). Thus, the frustration of academic doing research and carrying out entrepreneurial activities can be expressed in a variety of ways depending on the perception of the scholar or researcher. Table 1 shows a sample of the level of both internal and external causes of frustration faced by academics where the author mentioned that frustration in academic writing has long been recognised as being influenced by social context (Shenton, 2008; Sword et al., 2018).

Equally, due to some clashes that usually occurs in business and the scientific culture, for instance the continues tensions that occur every now and then between some scientists in relation to their respective universities sometimes results to the unsuccessful losses on either side Etzkowitz, (2001). Consequently, there is always a clear absence of the culture of joint venture and some complications vis-a-vis the affiliations with the university (Samsom & Gurdon, 1993). As such this analysis is considered the possible barrier to university success as well as a hindrance to entrepreneurship since most scientists out of frustration now acknowledge their limitations in their entrepreneurial and managerial skills.

Da Wan et al. (2015) identifies five major sources of frustration: bureaucracy; promotion and reward system; administrative duties; unrealistic expectations; lack of resources. In this light, this paper represents a first step of a wider research project that aims at enriching the debate on the main drivers of academic frustration and its effects on the university environment. Finally, this study responds to a specific call by Sword et al. (2018) who claims that more studies on the assessment of the actual impact of frustration in different contexts are needed, Academia included.

Methodology.

This research as earlier mention is carried out on individual bases across psychological and managerial literature. Here, we try to establish a link existing between academics carrying out their normal job (teaching and doing research) as well as their perception, intentions, and behaviours towards entrepreneurial activities across the university. The empirical study is focus on the collection of data with the help of a survey which shall further be clarified in this section. This research is built on the collection of mainly primary data with little or no secondary data involved as we seek to come up with a new data base that will help to shape the nature of this research.

Since this research seeks to bring out the relationship and precisely the frustration existing between being an academic and an entrepreneur, the study participant that were suitable for this type of survey were university professors and assistants. One of the reasons being that these are academics who have already attain a certain level of education and have accumulated enough experience which could permit them to want to get involve into entrepreneurial activities or pursue other ventures. In addition, most spinoffs from universities in recent years are operated by university professors who are said to have gain much satisfaction in operating such entities thus contributing enormously to the society (Wiklund et al., 2019).

The fact that there also exist other group of participants who could as well taken part in this survey and are not included does not means that they are exempted from getting frustrated in their early career building activities. For instance, the PhD and post-doctoral students. This group of people as suggested by the framework of this research are said to be either at their early stages of career building or in the transition stage. Thus, we thought that this category of people might need enough time to concentrate on building their academic career rather than getting involve in their early stage in entrepreneurial activities. Another criterial used in this research in the exclusion of these category of people is because it seeks to narrow down the sample of participant to a group of people who in this case are university professors and associate professors. The reason is to come out with a clearer and accurate data thus, reducing the level of biasness of the sample

In this paper, we adopt the guidelines for scale development procedures described in the psychometric literature to develop our measure of academic frustration (i.e., Bagozzi & Yi, 1988; Cortina, 1993; DeVillis,1991). Our empirical analysis is carried out following a well-defined three-step process: a) item generation, b) item allocation and refinement, c) scale validation.

a) Item generation

During the first phase, to consistently generate our items we began by creating a list of possible causes in which academic frustration might occur. On this purpose, we organised a focus group and met a sample of 14 scholars and conducted a deep qualitative interview to investigate the main factors causing frustration of their job. All information collected were recorded and ex post analysed using qualitative world clustering for detecting the main areas of frustration and allocate them to wider conceptual categories.

We integrated obtained data by reviewing the literature, examining existing items and scales, asking experts in the area, and using our personal anecdotes according to the analytical

process described by Carlson et al. (2006). At the end of this item generation and refinement process, 6 exhaustive constructs with 5-point self-report assessing Likert items were obtained:

1. *Dissatisfaction with Red tape (3 items)*
   - Administrative activities take up too much of my working time
   - When it comes to managing red-tape, in my institution things become over complicated and long
   - I get frequently irritated by the level of red-tape in my organization
2. *Dissatisfaction with teaching/relationships with students (4 items)*
   - Students appreciate my teaching
   - My students are motivated
   - My students challenge me
   - I am satisfied with my teaching activity
3. *Dissatisfaction with job progression (3 items)*
   - I have the impression there is no real meritocracy in the progression of academics
   - In my experience the hiring system is not objective
   - Evaluation systems in academia are biased and do not really reflect the personal capability
4. *Dissatisfaction with fund raising (5 items)*
   - It is extremely time-consuming to collect external research funds (writing projects, responds to EU calls etc.)
   - It is difficult to get funds for my research
   - It is difficult to find reliable research partners
   - I am not awarded for the fund I am able to raise
   - Spending research funds according to the norms and regulations is overwhelming
5. *Dissatisfaction with relationship with peers (3 items)*
   - It is difficult for me to keep good relationship with many colleagues
   - Often, I do not feel supported by my colleagues
   - There are big differences between my workload and my colleagues'
6. *Dissatisfaction with evaluation of research (3 items)*
   - I have the clear impression that groundbreaking papers receive severe criticism
   - In general, I think that the peer review system is not fair
   - In my experience, the quality of reviewers is not high

b) Item allocation and refinement

In the second phase of this analysis, based on the item generation phase, a questionnaire was created. The scale of "Dissatisfaction with Job Progression" has been reversed in the questionnaire to control for and/or identify acquiescence response bias (Herche & Engelland, 1996). Once we collected 106 observations, we proceeded with a data screening phase (using RStudio 3.6.2.: a free software environment for statistical computing and graphics.), composed by the detection of unengaged respondents, inconsistent answers and potential outliers, a final sample of 91 observations were obtained.

The responses were factor analysed with a principal components exploratory factor analysis (EFA) applying a varimax rotation based upon correlation matrix. For determining the optimal number of factors, we considered multiple criteria methods described by Ford et al. (1986) and Stevens (1992) including an assessment of eigenvalues and average variance extracted (AVE). Finally, a check for non-redundant items were performed in order to avoid within-factor correlated measurement error (Bagozzi & Yi, 1988).

After the creation of different EFA models, the software RStudio 3.6.2. pointed out that the optimal number of factors for the principal components EFA is 4 (11 out of 21 initial items were empirically selected obtained through the usage of the "n Factor" function inside RStudio 3.6.2.). According to it, we compared the principal components EFA model coming from the "Item generation" phase to the optimal one and got significantly better results in the second case. In addition to this principal component EFA, we conducted confirmatory factor analyses (CFAs) to ensure that the distinction is warranted. The results indicated that the four-factor model fits the data significantly better than the six-factor model (f.i. RMSEA goes from 0.064 to 0.015; gfi from 0.818 to 0.929).
The final configuration of the multi-dimensional scale coming from the principal component EFA on an empirical basis are represented in Table 1.

Table 1: Principal component analysis of academic frustration

	Principal Component 1	***Principal Component 2***	***Principal Component 3***	***Principal Component 4***
Administrative activities take up too much of my working time	***0.761***	*0.042*	*-0.152*	*0.072*
Managing bureaucracy at my institution is complicated	***0.882***	*0.070*	*-0.123*	*0.110*
I get frequently irritated by the level of bureaucracy in my organization	***0.903***	*-0.033*	*-0.091*	*0.124*
Students appreciate my teaching	*-0.011*	***0.822***	*0.046*	*0.242*
My students are motivated	*0.075*	***0.804***	*-0.101*	*-0.241*
I am satisfied with my teaching activity	*0.024*	***0.756***	*0.091*	*0.115*
I am/was satisfied with the promotional process overall (reversed item)	*-0.091*	*0.210*	***0.714***	*-0.310*

I understand/understood the criteria for achieving promotion (reversed item)	*-0.050*	*-0.192*	***0.803***	*0.061*
I feel/felt supported in my advancement for promotion (reversed item)	*-0.342*	*0.112*	***0.702***	*-0.183*
In general, I think that the peer review system is not fair	*0.130*	*0.083*	*-0.200*	***0.836***
In my experience, the quality of reviewers is high	*0.143*	*0.051*	*-0.071*	***0.821***
Proportion of variance	*0.30*	*0.26*	*0.23*	*0.22*
Cronbach's Alpha	*0.828*	*0.710*	*0.663*	*0.686*

Source: authors' own elaboration

c) Scale validation

The last phase consists in the determination of operational measures, through a CFA model. Results are proposed in Table 2.

To check the internal validity of constructs, we computed the Cronbach's Alpha. Furthermore, in the light of a relatively low sample size, we also report the Average Interim Correlation (AIC), following the scientific procedure proposed by Clark and Watson (1995), since this coefficient as no dependency on the number of observations. Results are presented in the table below.

Table 2: the operational measures of academic frustration

Construct/Items	***Standardized loadings***	***Composite Reliability/Omega (AVE/AIC)***
Dissatisfaction with red tape - *5-point self-report assessing Likert scale* *To what extent do you agree with the following statements*		***.841 (.645/.691)***
1. *Administrative activities take up too much of my working time*	***.632***	
2. *Managing bureaucracy at my institution is complicated*	***.818***	
3. *I get frequently irritated by the level of bureaucracy in my organization*	***.932***	

Dissatisfaction with teaching/relationships with students *- 5 point self-report assessing Likert scale* *To what extent do you agree with the following statements* *1. Students appreciate my teaching* *2. My students are motivated* *3. I am satisfied with my teaching activity*		 ***.782*** ***.626*** ***.617***	***.718 (.454/.419)***
Satisfaction with job progression *- 5 point self-report assessing Likert scale* *To what extent do you agree with the following statements* *1. I am/was satisfied with the promotional process overall* *2. I understand/understood the criteria for achieving promotion* *3. I feel/felt supported in my advancement for promotion*		 ***.670*** ***.502*** ***.753***	***.674 (.436/0.379)***
Dissatisfaction with evaluation of research *- 5 point self-report assessing Likert scale* *To what extent do you agree with the following statements* *1. In general, I think that the peer review system is not fair* *2. In my experience, the quality of reviewers is high*		 ***.795*** ***.657***	***.692 (.532/.522)***
CFA Goodness of Fit (RMSEA)	***.928 (.015)***		
Sample Size: 91	***NFI .882, NNFI .996 CFI .997 IFI .997 RFI .823***		

Source: authors' own elaboration

Findings. In the present work, we developed and empirically validated a multi-dimensional measure of academic frustration. The final 11 items are grouped into 4 types of academic frustration:

1. Dissatisfaction with Red tape (3 items)
   - Administrative activities take up too much of my working time
   - When it comes to managing red-tape, in my institution things become over complicated and long
   - I get frequently irritated by the level of red-tape in my organization
2. Dissatisfaction with teaching/relationships with students (3 items)
   - Students appreciate my teaching
   - My students are motivated
   - I am satisfied with my teaching activity
3. Satisfaction with job progression (3 items) (reversed)
   - I am/was satisfied with the promotional process overall
   - I understand/understood the criteria for achieving promotion

- I feel/felt supported in my advancement for promotion

4. Dissatisfaction with evaluation of research (2 items)
   - In general, I think that the peer review system is not fair
   - In my experience, the quality of reviewers is not high

Research limits. The present research is not free of limitations. Thus, as we tried to create an exhaustive framework on the main factors driving academic frustration inside this multi-step scale development, there are certain limitations that can be explored in future research.

First, we validated the scales on the basis of a relatively low sample, characterized by data that were mainly collected from Italian, Slovenian and English academics (there is a limit based on a narrow geographical scope and we cannot ensure generalizability Netemeyer et al., 2003)). Hence, it is appropriate to test measurement invariance via comparison of samples coming from different countries (the same geographical scope also applies for the creation of the focus group, in the phase of item generation).

Second, our study measures academic frustration as a self-report assessing Likert scale: it clearly represents a potential weakness, since the susceptibility to response biases may compromise the validity of the assessments (Kreitchmann et al., 2019).

Practical implications. This explorative study is focused on the academic world in order to provide literature with a multi-dimensional solid measure of academic frustration and responds to the call of Sword et al. (2018) that claimed for the necessity of an higher specificity on the study of the nuances that frustration may have in different contexts. According to Torrisi and Pernagallo (2020), the inspection of drivers determining academic frustration is crucial in order to prevent outflows of highly skilled human resources.

Originality of the study. Even if much more theoretical and empirical research is needed to confirm and explain our findings, this paper has a certain level of innovativeness. Indeed, it identifies a multi-dimensional measure of the academic frustration, a topic that is still in its infancy in scientific literature. Thus, there is a compelling necessity for providing new measures of academic dissatisfaction (Torrisi & Pernagallo, 2020).

Our systematic approach is strictly based on the theoretical guidelines (Bagozzi & Yi, 1988; Cortina, 1993; DeVillis,1991; Carlson et al., 2006) in order to furnish new and solid scales to measure academic frustration and put more light on the paramount importance of enhancing the academic debate on this topic.

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General conclusion

This thesis has mainly focus on technology transfer in academia and on the perception of researchers in the management of both research and entrepreneurial activities. As already mention in this research, the first and the second papers are closely linked to each other as the second one is a continuation of the first. In analysing the various modes of transferring technology from academic to the society, we realised that most of the transfer is carried out through technology transfer offices. This phase of the research that is proposed by Chesbrough (2003) is totally contrary to that earlier mentioned by Von Hippel (2003) which was mostly focus in making sure that the society benefits from this technology or knowledge created at no cost. However, for over the years, things have greatly changed due to globalisation and new technology developments which have led to so much competition amongst universities and industries. Thus, Universities must survive in this era not only from what the governments or some industries offer them as grants but must fight for themselves. This is because they must sustain their workers, maintain their collaborations with companies as well as overcoming the challenges of limited funds.

With this idea in mind, the university had to harmonise and protect the intellectual properties of researchers by creating specific institutions like the TTO to cater for these innovations. Thus, selling, or commercialising research using these offices have encouraged researchers from all field of studies to increase their level of production capacities since they are sure of selling their inventions. This research also demonstrated that for TTO to better perform in marketing these innovations, some strategies had to be put in place to outsmart the adversary. Therefore, we suggested that adopting the idea of dynamic capability (sense, seize and reconfigure) proposed by Teece (2003) could help in developing new business models in these offices. From the data collected through interviews, we realised that most of these offices were involve more in seizing opportunities around them than in sensing them. This is because most TTO were either very young with little experience or had few members from diverse background. As a result of this diversity, staff's idea on developing new business model was based mostly on their respective backgrounds. This also explain why reconfiguring new business model was not well appreciated by most of the offices. In a not shell, implementing dynamic capabilities in TTO is beneficial for the development of new business model or modifying existing ones.

On the other hand, researchers have gradually diverted from carrying out research activities to involving more in other activities such as that of entrepreneur. From this perspective, we tried to find out the "why" and the "how" this happen and whether it is an opportunity for researchers to enhance their academic skills or they are just being frustrated in their jobs. In addressing the above doubts, we tried to explore the drivers of academic frustration bring and the role it plays in influencing academics to wanting to involve in different activities like entrepreneur (that is motivations of academics in creating spinoffs). This research was carried with the use of a survey to understand the perception of researchers doing their normal jobs and getting involved in entrepreneurial activities. For a better understanding, this part was divided in to two where the validity of the constructs used in the survey was measured. The data collected from the survey was tested with the help of Principal Component Analysis and validated thanks to the specific statistical tool known as the Cronbach's Alpha. From the preliminary results, a greater part of the constructs was measured and validated which permit

us to move to the next phase of the research (as this study is said to be a part of a greater research which is ongoing).

Contribution

Nevertheless, this research has greatly contributed in the existing literature in several ways; firstly, this research is the first to analyses the financial benefits of technology transfer to technology transfer offices which was done by comparing the various modes of technology transfer and evaluating their outcomes. It has also contributed to the literature by bringing out the relationship existing between business model and dynamic capability. This idea if well implemented by university stakeholders could enhance the activities of the TTO and as such bring in more money in the university. In addition, the fact that researchers are gradually involving in entrepreneurial activities have drawn the attention of most researcher to the role that passion and frustration could play in their entrepreneurial intention. This has greatly contributed to the literature as researchers could now evaluate these two phenomena and take the right decision to either remain in the academic field or to move to companies or even to manage both activities at a time without any compromise.

Limitations and recommendations

Generally, the limitation of this thesis is the sample size used, since we carried our analysis in the second paper based only on 6 TTOs and in the third paper based on only 108 participants. This limitation could be corrected if the sample were huge to avoid some biasness in the analysis. In addition, we focused on only TTO in the Balkans and Baltic areas without extending to other areas in the world. By considering TTO worldwide, this could provide us with a better view and understanding on how the concept of dynamic capability could be implemented in developing new business models.

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